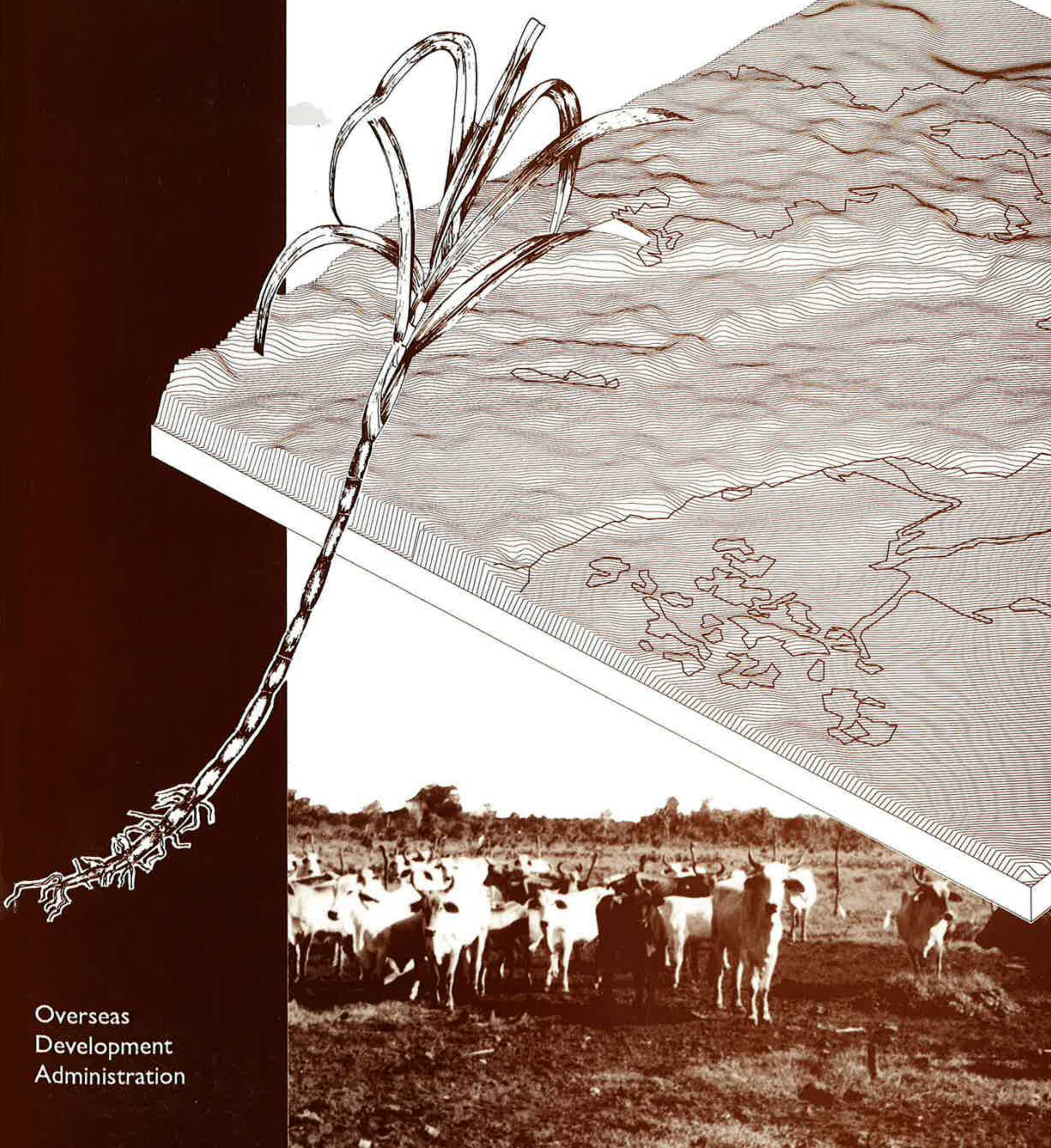
Land resource assessment of Northern Belize (NRI Bulletin 43, Vol 2)

Natural Resources Institute

Bulletin 43

LAND RESOURCE ASSESSMENT OF NORTHERN BELIZE

Volume II



Overseas Development Administration

N.B. The following maps are included with this digital document as attachments:

Map 2a - **Land Use in 1969-72 and 1987-88**

Map 2b - **Land Use in 1969-72 and 1987-88**

Map 2c - **Land Use in 1969-72 and 1987-88**

Map 2d - **Land Use in 1969-72 and 1987-88**

LAND RESOURCE ASSESSMENT OF NORTHERN BELIZE

R. B. King, I. C. Baillie, T. M. B. Abell, J. R. Dunsmore, D. A. Gray, J. H. Pratt, H. R. Versey, A. C. S. Wright and S. A. Zisman

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Addenda

APPENDIX 1: LAND SUITABILITY OF LAND SYSTEMS AND SUBUNITS

Land system①		Area (km²)	Main subunits②	Percentage area within land system	Current land use	Main soil types	Agricultural Value	Main limiting factors③	Conservation Value	Land suitability: Beans	Cacao	Cashew	Citrus	Coconuts	Coffee (Robusta)	Cotton	Groundnuts	Maize (mechanised)	Milpa (shifting cultivation)	Papaya	Pasture	Pineapple	Rice (mechanised)	Root crops	Shrimps	Sorghum	Sugar-cane	Timber	Provisional recommendations
NORTHERN COASTAL PLAIN																													
ZY	Corozal Saline Swamps	884	Savanna (ss)	41	Hunting	Shipstern + Ycacos	5	Root room, nutrients, salinity, wetness	1	N2wz	N2wz	N2wz	N2wz	N1n–N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N1n–N2wz	N2z	N2wz	S2k–N1k	N2wz	N2wz	N2wz	Shrimp mariculture, conservation
			Swamp (⫫)	29	None	Ycacos	5	Wetness, salinity	1	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	S2k–N1k	N2wz	N2wz	N2wz	Shrimp mariculture, conservation
			Mangrove (m)	22	None	Ycacos	5	Wetness, salinity	1	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	S2k–N1k	N2wz	N2wz	N2wz	Conservation
			Tree savanna (ts)	8	None	Shipstern + Ycacos	5	Root room, nutrients, salinity	1	N2wz	N2wz	N2wz	N2wz	N1n–N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N1n–N2wz	N2z	N2wz	S2k–N1k	N2wz	N2wz	N2wz	Conservation
			Saline plain (sl)	0.1	None	Buttonwood	5	Nutrients, drainage, salinity	1	N2nz	N2nz	N2nz	N2nz	N1nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	S2m–S3n	N2nz	N2nz	N2nz	Shrimp mariculture
ZZ	Louisville Plain	335	Undulating plain (U)	77	Sugar-cane	Louisville + Concepcion > Remate	2	Moisture, drainage, nutrients, root room	4 > 2	S2mn–S3wn	N1mr–N2mr	N1r–N2r	S2mm–N1nr	S2mn–N1nr	S1–N1mr	S2mn–N1mn	S3mn>N1wr	S2mn–N2mk	S2mn–S3mn	S2mn–N1n	S2mn–S3m	S2n–N1n	S2mn–N2m	S3mn	N2z–	S2mn>S3m	S1–S3mn	S1	Sugar-cane, maize, vegetables
			Lower slope (W)	23	Very limited sugar-cane	Gleyed Louisville > Pucte	3 > 2	Drainage, nutrients, root room	4 > 2	S3wn–N2w	N2wn	N2w	N1wn>N2w	S3w>N1w	N2nw>N1w	S2nw–N2w	N1wr–N2w	S1–N2w	S1–S3*wn	S2wn–N2w	S1–S3w	N1wn–N2wn	S1–S3mn	S3n>N1w	N2z–	S2w–N2w	S1–N1w	S3w	Conservation
OW	Hondo Swamps	113	Marsh forest plain (h)	44	Very limited sugar-cane	Pucte + Sibal	4–5	Wetness	3 > 1	N2w	N2w	N2w	N2w	N1w–N2w	S3w–N2w	N2w	N2w>N1w	N1w–N2w	S2*wn–N2w	N1w–N2w	S2w–N1kw	N1wn–N2w	S2n–N1kw	S3w–N2w	N2z–	S2w–N2w	S2w–N2w	N2w	None
			Swamp with mangrove (Ml)	42	None	Sibal	5	Wetness	1	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1z–	N2w	N2w	N2w	Fishing, conservation
			Herbaceous swamp (l)	8	None	Sibal	5	Wetness	3	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1kw	N2w	N1kw	N2w	N2z–	N2w	N2w	N2w	None
			Savanna plain (m)	5	None	Sibal	5 > 4	Wetness	2	N2w	N2w	N2w	N2w	N2w>N1w	N2w>S3w	N2w	N2w	N2w>N1w	N2w>S2*wn	N2w>N1w	N1kw>S2w	N2w>N1wn	N1kw>S2n	N2w>S3w	N2z–	N2w	N2w>S2w	N2w	Conservation
ZI	Xaibe Plain	691	Flat plain (N)	76	Very limited sugar-cane	Xaibe + Puluacax + Remate	2–3	Moisture, nutrients	3 > 2	S2mn–N2w	N1mn–N2mn	N2r	S2mn–N2mr	S2nr–N1w	S2mn–N2w	S3mn–N2mn	S3mn>N2w	S2wn–N1mn	S2mn–N1w	S2mn>N1wn	S2mn–N1wn	S1–N1w	N2mn>S3mn	S2mn–N1mr	N2z–	S2mn–S3mn	S2mn–S3mn	S1	Pineapple, sugar-cane, papaya, conservation
			Lower slope (W)	14	Limited sugar-cane	Puluacax > (Remate + Xaibe)	2 > 3	Nutrients	2	N1wn	S3w–N2w	N2rw>N1w	S3wn–N2w	S3w–N1w	S3wn–N2w	N1wm–N2wn	S3w–N2w	S2wn–N1wn	S2n–N1w	N1wn>S2wn	S2wn–N1wn	S2w–N1w	S2n–S3mn	S2n–N1r	N2z–	S3wn–N2wn	S2wn–N1wn	S3w	Conservation
			Undulating plain (U)	9	Sugar-cane	Xaibe + Remate	2	Moisture, nutrients	3 > 2	S2mn–N1m	N1mn–N2mn	N2r	S2mn–N2mr	S2nr–N1nr	S2mn–N2mr	S3mn N2mn	S3mn	S2mn–N2mk	S2mn–N2m	S2mn>N2mn	S2mn>N1m	S1 S3mn	N2mn>S3mn	S2mn–N1mr	N2z–	S2mn–N1mk	S2mn–N1mn	S1	Pineapple, sugar-cane, papaya, bananas
JI	Consejo Plain	50		100	Widespread sugar-cane	Consejo	5	Root room, nutrients, workability	3	N2wr	N2r	N2r	N1r–N2r	S2n–N1wn	N2nr	N2r	N2nr	S3r–N1r	N1rw	S3nr	S2mn–N1w	N1n–N2w	N2m	N2nr	N1k	N2w	S3nw	N1r	Tourism
SW	Sibal Swamps	616	Herbaceous swamp (l)	64	None	Sibal	5	Wetness	3	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1kw	N2w	N1kw	N2w	N2z–	N2w	N2w	N2w	None
			Savanna plain (m)	23	None	Sibal	5	Wetness	2	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1kw	N2w	N2w	N2w>S3w	N2z–	N2w	N2w	N2w	Conservation
			Marsh forest plain (h)	14	None	Sibal	5	Wetness	3 > 1	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1kw	N2w	S3f–N2w	S3w–N2w	N2z–	N2w	N2w	N2w	None
AN	West Ambergris Plain	25		100	None	Ycacos + Shipstern	5	Wetness, salinity, root room, nutrients	1	N2wz	N2wz	N2wz	N2wz	N1n–N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N1n–N2wz	N2kz	N2wz	N1k>S2k	N2wz	N2wz	N2wz	Conservation, tourism
AI	North Ambergris Plain	14		100	None	Shipstern	5	Root room, moisture, nutrients	3	N2mn	N2r	N2r	N2r	N1n	N2r	N2r	N2mn	N2mn	N2mr	N2r	N1m	N1n	N2m	N2mn	N1k	N2mn	N2m	N1r	Conservation
AB	Ambergris Strand Plain	8		100	Coconuts, urban development	Ambergris	4	Moisture, salinity	1	N2mn	N2mn	S3n	N1mn	S3n	N2mn	N2mn	N2mn	N2mn	N2mn	N2mn	S3mn	S3n	N2m	N2m	S3m	N1mn	N2mn	N1z	Tourism, conservation
ZW	Corozal Swamps	22		100	Very limited maize	Puluacax + Xaibe	5 > 3	Nutrients, wetness	3 > 1	N1wn–N2w	S3w–N2w	N2rw	S3b–N2w	S3w–N2w	S3wn–N2w	S3w–N2wn	S3w–N2w	S3wn–N2w	S2mn–N2w	N2w>S2wn	S2wn–N1w	S2w–N2w	S2n–N1kw	S2n–N2w	N2z–	S3wn–N2w	S3b–N2w	S3w–N2w	Pasture, rice, conservation
ZN	Shipstern Plain	67	Glady forest plain (H)	70	None	Puluacax > (Xaibe + Remate + Ycacos)	3 > 5	Nutrients, drainage	2 > 1	N1wn>N2wz	S3w–N2w	N2w>N1w	S3wn–N2w	S3w–N2wz	S2wn–N2w	N1wn–N2w	S3w–N2w	S2wn–N2wz	S2n–N2wz	N2w>S2wn	S2wn–N2wz	S2w–N2wz	S2n–N2z	S2n–N2wz	S3z+>N1k	S3wn–N2w	S3ab–N2wz	S2w–N2wz	Conservation
			Clumped tree savanna (N)	30	None	Ycacos > (Puluacax + Xaibe + Remate)	5 > 3	Wetness, salinity, nutrients	1 > 2	N2wz>N1wn	N2w>S3w	N2w>N1w	N2w>S3wn	S3w–N2wz	N2w>S3wn	N2w>N1wm	N2w>S3w	S2wn–N2wz	N2wz>S2n	N2w>S2wn	S2wn–N2wz	N2wz>S2w	S2n–N2z	S2n–N2wz	N1k>S3z–	N2wz>S3wn	N2wz>S3ab	N2wz>S2w	Conservation
			Mangrove (m)	0.3	None	Ycacos	5	Wetness, salinity	1	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	S2k–N1k	N2wz	N2wz	N2wz	Conservation
OZ	Lazaro Plain	514	Undulating plain (U)	90	Sugar-cane, limited pasture	Lazaro > Pixoy	2	Nutrients, moisture	4	S2mn	N1m	S2n–S3nr	S2nm–S3nm	S1–S3nm	S2m–N1mn	S2mn–S3mn	S1–S3n	S2mn	S1–S2nm	S2mn–N1mn	S1–S2n	S1–S2n	S3mn–N1mn	S2mn	N2z–	S1–S2n	S1	S1	Sugar-cane, vegetables, tree crops, pasture
			Lower slope (W)	10	Very limited cultivation	Mottled (Lazaro > Pixoy) + Pucte	3–4	Drainage, nutrients	1	N1wn–N2w	N1wn–N2w	N1wn–N2w	N1wn–N2w	S2w–N1w	N1w–N2wn	S3w–N2w	S3nw–N2w	S3nw–N2w	S3*wn–N1wn	S3wn–N2w	S1–S3w	S3wn–N1wn	S2mn–S3mn	S2mn–S3w	N2z–	S3nw–N2w	S2w–N1w	S3w	Conservation
OK	Shipyard Plain	622	Flat plain (N)	43	Sugar-cane, pasture, sorghum	Yalbac > Lousisville	2–3	Workability, root room, moisture, nutrients	2 + 4	S2n>S3wn	S3m–N2mr	N2nr	N1r>S3nm	S3mr>S2n	S3mn	S3nm	S2m>S3mn	S2nk–S3k	S1–S3mn	S2mn–N1mn	S1–S3m	N1n	S2m–N1m	S3mn	N2z–	S1–S3k	S1–S2nm	S1	Arable, pasture
			Lower slope (W)	31	Very limited sugar-cane	Mottled Yalbac + Pucte	3–4	Workability, root room, drainage, nutrients	3 > 1	N1w–N2w	N1w–N2w	N2w	N1wn–N2w	N1w	S3mn–N1m	S3wn–N2w	N1w–S3mn	S2kw–N2w	S1*–S3*wn	S3wn–N2w	S2w–S3w	N1wn–N2wn	S1–S3n	S3w–N2w	N2z–	S2kw–N2w	S2w–N1w	S3w	Conservation
			Undulating plain (U)	26	Limited sugar-cane, milpa	Yalbac	2–3	Workability, root room, moisture, nutrients	2 > 4	S2nk	S3m–N1mn	N2nr	N1r>S3nm	S3mr	N1w–N2w	S3mn	S2m>S3mn	S2nk–S3k	S1–S3mn	S2mn–N1mn	S1–S2m	N1n	S3m–N1m	S3mn	N2z–	S1–S3k	S1–S2nm	S1	Arable, pasture
			Hillock (H)	0.05	None	Yalbac	4	Erosion, root room, moisture, nutrients	1	N1e	N1mn	N2nr	N1mn>S3ne	S3re	N1m	N1e	N1e	N1e	N1e	S3e	S3e	N1n	N2ms	S3mn	N2z–	N1e	S3e	N2e	Conservation
			Moderately sloping valley (V)	0.05	None	Yalbac	4	Erosion, root room, moisture, nutrients	1	N1e	N1mn	N2nr	N1mn>S3ne	S3re	N1m	N1e	N1e	N1e	N1e	S3e	S3e	N1n	N2ms	S3mn	N2z–	N1e	S3e	N2e	Conservation

	Land system[1]	Area (km²)	Main subunits[2]	Percentage area within land system	Current land use	Main soil types	Agricultural Value	Main limiting factors[3]	Conservation Value	Land suitability																			Provisional recommendations
										Beans	Cacao	Cashew	Citrus	Coconuts	Coffee (Robusta)	Cotton	Groundnuts	Maize (mechanised)	Milpa (shifting cultivation)	Papaya	Pasture	Pineapple	Rice (mechanised)	Root crops	Shrimps	Sorghum	Sugar-cane	Timber	
NORTHERN COASTAL PLAIN (cont.)																													
FP	San Felipe Plain	228	Undulating plain (U)	81	Limited sugar-cane, pasture	Felipe > (Boom + Tok), BV : Erindale	4	Wetness, moisture, nutrients	3 > 2	N1wn>N2mn	N2wn	S3wn-N2n	N1wn>N2wn	S3wn-N2mn	N2wn	N2n	S3mn>N2wn	N1wn>N2n	N2wn	N1wn>N2n	S3wn>N2wn	S2mn-N1mn	S3mn>N2m	S3mn-N2mn	N2z-	N1wn>N2n	S3wn-N2n	Pine: S3nr	None
			Redeposited old alluvial wash (pW)	18	None	Haciapina > Sennis	4	Nutrients, drainage, root room	3	N2wn>S3wn	N2n>S3wr	N2w>N1r	N1wn>S3n	S2w-N1wn	N2wn>S3w	N2wn>N1n	N2wn>S3wn	S2b-N2wn	S2*w-N2wn	S3wn-N2wn	S3wn>S2m	S3wn	S2nq-N1m	S2n-N2nm	N2z-	N2wn>S2b	N2wn>S3w	S3w	Pine, pasture, rice
			Floodplain (F)	1	None	Haciapina	4	Nutrients, wetness	3	N2wn	N2wn	N2w	N1wn	N1wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	S3wn	S3wn	S2nq-S3nq	S3n	N2z-	N1kw-N2kw	N2wn S3wn	S3w	Pine, pasture, rice
BJ	Jobo Plain	723	Flat plain (N)	96	Coconuts, pasture, sugar-cane	Altun Ha > Puluacax	4	Workability, moisture, nutrients, wetness	3 > 1	N1kn	S3w-N2mn	S3nr-N2r	S2m-N2nr	S2mn-N1mn	S2mn-N2nr	N1kn-N2km	N1kr	S2wn-N2km	S2mn-N1mn	S3mn-N2nr	S2nk-S3nk	S2mn-N1nr	S2n-N2km	N1kr>S3mn	N2z-	S3kn-N2kn	S2mn-N2m	N1r	Pasture, coconuts, pineapple
			Lower slope (W)	4	None	Mottled Jobo + Pucte	4	Workability, nutrients, wetness	3 > 1	N2w	N2w	N2w	N2w	N1w	S3w-N2nw	N2kw	N2kw	N1kw-N2w	N1w	N1wn-N2wn	S3wk-N1w	N1w	S2k	N1kr>S3w	N2z-	N1kw-N2kw	S3wn>N1w	S3w	Rice
ZH	Northern Bulkhead Plain	44	Flat plain (N)	94	Very limited milpa	Xaibe + Puluacax > Ycacos	4	Nutrients, drainage	3 > 1	S2mn-N2wz	S3w-N2wz	N2w>N1w	S2mn-N2wz	S3w-N2wz	S3wn-N2wz	N1wn-N2w	S3w-N2w	S2wn-N2w	S2mn-N2w	S2w>S2wn	S2wn-N2wz	S2w-N2w	S2n-N2z	S2n-N2w	N2bz-	S3wn-N2w	S3a-N2wz	S2w-N2w	Pasture, pineapple, rice
			Lower slope (W)	7	Very limited milpa	Puluacax > (Xaibe + Ycacos)	4	Nutrients, wetness	2 > 1	N1wn-N2wz	S3w-N2w	N2w>N1w	S3wn-N2w	S3w-N2wz	S3wn-N2w	N1wn-N2w	S3w-N2w	S2wn-N2wz	S2n-N2wz	N2wz>S2wn	S2wn-N2wz	S2w-N2w	S2n-N2z	S2n-N2w	S3z->N1k	S3wn-N2w	S3ab-N2wz	S2w-N2w	Conservation
OP	August Pine Plain	258	Undulating plain (U)	73	Very limited pasture	Boom > (Tok + Backlanding + Crooked Tree)	4 > 3	Moisture, wetness, nutrients	3 > 1	N2mn	N2mn	S1-N2r	S2mn-N2mn	S2mn-N2mn	N2mn>N1mn	N2mn	S3mn	N2mn>S3mn	N2mn	N2m>S3mn	S2mn-N1wn	S2mn-N1mn	S3mn-N2m	N2mn>S3mn	N2z-	N1mn-N2mn	N1mn-N2mn	Pine: S3nr	None
			Redeposited old alluvial wash (pW)	26	None	Haciapina > Sennis	4	Nutrients, drainage, root room	3	N2wn>S3wn	N2n>S3wr	N2w>N1r	N1wn>S3n	S2w-N1wn	N2wn>S3w	N2wn>N1n	N2wn>S3wn	S2b-N2wn	S2*w-N2wn	S3wn-N2wn	S3wn>S2m	S3wn	S2nq-N1m	S2n-N2mn	N2z-	N2wn>S2b	N2wn>S3w	S3w	Pine, pasture, rice
			Floodplain (F)	1	None	Haciapina	4	Nutrients, wetness	3	N2wn	N2wn	N2w	N1wn	N1wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	S3wn	S3wn	S2nq-S3nq	S3n	N2z-	N2wn	N2wn	S3w	Pine, pasture, rice
QF	Tok Plain	268	Flat plain (N)	93	Shrimp farming, urban development	Tok > (Boom + Buttonwood)	5	Wetness, nutrients	3 > 1	N2wn>N1kn	N2wn	N2wn>33mn	N2wn>N1m	N1wn>S3wn	N2wn	N2wn	N2wn>N1kr	N2wn	N2wn	N2wn>N1m	S2wn-N2mn	S2mn-N1wn	S2mn-N2m	N1wn>N2mn	N2z->S3m	N2wn>N1mn	N1wn-N2wn	Pine: S3nr	Conservation, shrimp mariculture
			Redeposited old alluvial wash (pW)	7	Very limited cultivation	Haciapina	4	Nutrients, drainage	3	N2wn	N2wn	N2w	N1wn	S3wn-N1wn	N2wn	N2wn	N2wn	N2wn	N2wn	N1wn-N2wn	S3wn	S3wn	S2nq-S3nq	N2mn	N2z-	N2wn	N2wn	S3w	Pine, pasture, rice
			Floodplain (F)	0.3	None	Haciapina	4	Nutrients, wetness	3	N2wn	N2wn	N2w	N1wn	N1wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	S3wn	S3wn	S2nq-S3nq	S3n	N2z-	N2wn	N2wn	S3w	Pine, pasture, rice
BH	Estevez Plain	24		100	None	Altun Ha + Tok > Boom	4	Workability, moisture, nutrients, wetness	2 > 1	N1kn-N2wn	S3w-N2n	S3n-N2n	S2nr-N2n	S2mn-N1n	S3mn-N2n	N1kn>N2kn	N1kr>N2wn	S2wn-N2kw	S2mn-N2wn	S3mn>N2wn	S2n-N2wn	S2mn>N1n	S2n-N2m	S3mn-N2mn	N2z-	S3kn-N2zn	S2mn-N2wn	S3wpbe-N1r	Conservation
KF	Crooked Tree Plain	157	Undulating plain (U)	71	Very limited cashew	Crooked Tree > Boom	3	Moisture, nutrients	3 > 1	N2m	N2mn	S1-S3mn	S2mn-N1mn	S2mn-S3mn	N1mn-N2mn	N2mn	S3mn	S3mn-N2mn	N2mn	S3mn-N2mn	S2mn-S3mn	S2mn	N2m>S3mn	N2m	N2z-	N1mn	N1mn-N2mn	S3n	Cashew, pasture, pineapple, conservation
			Redeposited old alluvial wash (pW)	16	None	Haciapina > Sennis	4	Nutrients, drainage, root room	3	N2wn>S3wn	N2n>S3wr	N2w>N1r	N1wn>S3n	S2w-N1wn	N2wn>S3w	N2wn>N1n	N2wn>S3wn	S2b-N2wn	S2*w-N2wn	S3wn-N2wn	S3wn>S2m	S3wn	S2nq-N1m	S2n-N2mn	N2z-	N2wn>S2b	N2wn>S3w	S3w	Pine, pasture, rice
			Low marine terrace (I)	11	Very limited pasture	BV:Double Head Cabbage > (Hattieville + Duck Run)	3	Nutrients	3	N1m	N2n	S1-N1w	S2n-N1n	S2n-N1w	N1n-N2n	N2n	S3mn-N1w	S3n-N2n	N2n	S3n-N2n	S2n-S3n	S2n-S3w	N2m>S3mn	N1m	N2z-	N1n	N1n-N2n	S3n	Cashew, pasture, pineapple
			Pitted plain (b)	2	None	BV:Double Head Cabbage > (Colonel English + Ycacos)	3 > 4	Nutrients, drainage, salinity	3	N1m>N2nr	N2n	S1-N2w	S2n-N2nr	S2n-N2w	N1n-N2n	N2n	S3mn-N2w	S3n-N2n	N2n	S3n-N2n	S2n-N2w	S2n-N2w	S3mn-N2w	N1m	N1a'	N1n	N1n-N2n	S3w-N2w	None
			Very poorly drained basin (B)	0.1	None	Ycacos	5	Wetness, salinity	2	N2wz	N2wz	N2wz	N2wz	N2w	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N1kw-N2wz	N2wz	N1kw-N2wz	N2wz	N1a'	N2wz	N2wz	N2wz	None
BN	Maskall Plain	21	Glady forest plain (H)	82	None	Altun Ha > Ycacos	4 > 5	Workability, nutrients, wetness	2 > 1	N2w	N2w	N2w	N2w	N1w>N2wz	N2w	N2w	N2w	N1kw>N2wz	N2wz	N2w>N1wn	S3wk-N2wz	N1w>N2wz	S2kn-N2z	N1kr>N2wq	S3z->N1k	N2w>N1kw	S3wn>N2wz	N1r-N2wz	Conservation
			Clumped tree savanna (N)	10	None	Ycacos > Altun Ha	5 > 4	Wetness, workability, nutrients, salinity	1 > 2	N2w	N2w	N2w	N2w	N2wz>N1w	N2w	N2w	N2w	N2wz>N1kw	N2wz>N1w	N2w>N1wn	S3wk-N2wz	N2wz>N1w	S2kn-N2z	N2wz>N1kr	N1k>S3z-	N2w>N1kw	N2wz>S3wn	N2wz>N1r	Conservation
			Mangrove (m)	8	None	Ycacos	5	Wetness, salinity	1	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	S2k-N1k	N2wz	N2wz	N2wz	Conservation
HX	Wamil Plain with Hills	78	Low karst (LK)	44	None	Shallow Yalbac > Chacluum	2-5	Shallow soils, workability, erosion	1	S2n-N2e	N1mn-N2e	N2mr>N1mn	S2n-N2e	S3mr-N2e	S2mn-N2e	S2mn-N2e	S3mk-N2e	S3b-N2e	S2m-N2e	S3mn-N2e	S1-N2e	S2n-N2e	N1m-N2s	S3mn-N2e	N2z-	S2m-N2e	S3b-N2e	S1-N2e	Conservation
			Undulating plain (U)	35	None	Yalbac + Chacluum + Ramgoat > Pasmore	2-4	Workability, root room, moisture, nutrients	2	S2nk-N1w	S3mn-N2mn	N1mn-N2wn	S2n-N1n	S2n-N1w	S2n-N2w	S2n-N1n	S3k-N1nr	S2m-N1w	S1-S3n	S2mn-N2w	S1-S3mn	S2n-N2wn	S1-N1m	S3mn-N2w	N2z-	S1-N1w	S1-S3n	S1	Conservation
			Rolling plain (R)	21	None	Yalbac	4	Erosion, workability, root room, moisture	1	S2nk-S3ke	S3mn-N1m	N2mr	S3ne-N1nr	S2n-S3mr	S3mn-N1m	S3me	S3ke	S3e	N1e	S3e-N1mn	S1-S3m	N1n	N2s	S3me	N2z-	S3e	S3e	S1	Conservation
			Lower slope (W)	0.1	None	Mottled Yalbac + Pasmore	3-4	Workability, root room, wetness, nutrients	2	S2wn-N1w	N1w	N2w	N1wn	S3w-N1w	N2w	S2wn-S3wn	N1w	S3w-N2w	S1*-N2w	S2wn-N2wn	S1-S3w	N1wn-N2wn	S1-S3m	S1-N2w	N2z-	S2w-N1w	S1-S3wn	S3w	Conservation
HZ	Hill Bank Plain	603	Flat plain (N)	66	Very limited milpa	Ramgoat + Chacluum + Chucum > (Yalbac + Irish Creek)	3	Workability, root room, wetness, nutrients	2	S3nk-N1w	S3nr-N2wn	N2n>N1rw	S2n-N2wn	S3n-N2wn	S2nr-N2wn	S2mn-N2wn	S3n-N2wn	S3nr-N2wn	S3mn-N2wn	S3mn-N2wn	S1-N2wn	S2n-N2wn	S3mn-N2mn	S3mn-N1w	N2z-	S2mn-N2wn	S3n-N2wn	S1	Timber, pasture, smallholder farming
			Undulating plain (U)	18	Very limited citrus, pasture	Ramgoat + Chacluum + Chucum > (Yalbac + Irish Creek)	3	Workability, root room, drainage, nutrients	2	S3nk-N1w	S3nr-N2wn	N2n>N1rw	S2n-N2wn	S3n-N2wn	S2nr-N2wn	S2mn-N2wn	S3n-N2wn	S3nr-N2wn	S3mn-N2wn	S3mn-N2wn	S1-N2wn	S2n-N2wn	S3mn-N2mn	S3mn-N1w	N2z-	S2mn-N2wn	S3n-N2wn	S1	Timber, pasture, smallholder farming
			Lower slope (W)	14	None	Chucum + mottled Yalbac + Irish Creek > Pasmore	3	Workability, root room, wetness, nutrients	2	N2w>S2w	N1w-N2w	N2w	N1w-N2w	S3w-N2wn	N1w-N2wn	S2wn-N2wn	N2mn>N1wn	S2wn-N2wn	S1*-N2w	S2wn-N2wn	S1-N2wn	N1w-N2wn	S1-S3m	S1-N2w	N2z-	S2k-N2wn	S1-N2wn	S3w	Rice
			Rolling plain (R)	1	None	Yalbac	4	Erosion, workability, root room, moisture	1	S2nk-S3e	S3m-N1m	N2mr	S3ne-N1nr	S2n-S3mr	S3mn-N1m	S3me	S3ke	S3e	N1e	S3e	S1-S2m	N1n	N2s	S3me	N2z-	S3e	S3e	S1	Timber, pasture
			Hillock (H)	0.2	None	Yalbac	4	Erosion, root room, moisture, nutrients	1	N1e	N1mn	N2nr	N1mr>S3ne	S3re	N1m	N1e	N1e	N1e	N1e	S3e	S3e	N1n	N2ms	S3mn	N2z-	N1e	S3e	N2e	Conservation
			Steep slope (S)	0.1	None	Yalbac	5	Erosion, root room, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z-	N2e	N2e	N2e	Conservation
			Low karst (LK)	0.05	None	Yalbac	5 > 3	Erosion, root room, moisture, nutrients	1	S3nk-N2e	S3nr-N2e	N2e>N1rw	S3n-N2e	S3n-N2e	S2nr-N2e	S3nr-N2e	S3n-N2e	S3nr-N2e	S3mn-N2e	S3mn-N2e	S1-N2e	S2n-N2e	S3mn-N2s	S3mn-N2e	N2z-	S2mn-N2e	S3n-N2e	S1-N2e	Conservation

Land system[1]		Area (km^2)	Main subunits[2]	Percentage area within land system	Current land use	Main soil types	Agricultural Value	Main limiting factors[3]	Conservation Value	Land suitability: Beans	Cacao	Cashew	Citrus	Coconuts	Coffee (Robusta)	Cotton	Groundnuts	Maize (mechanised)	Milpa (shifting cultivation)	Papaya	Pasture	Pineapple	Rice (mechanised)	Root crops	Shrimps	Sorghum	Sugar-cane	Timber	Provisional recommendations
NORTHERN COASTAL PLAIN (cont.)																													
HF	Spanish Creek Floodplains	2		100	None	BV:Lemonal	1	Flooding	4	S2n	S2r–S3r	S3r	S1–S3w	S2r	S2r	S3br	S3n	S3nd	S1*	S2r–S3r	S2f	S3f	S2fm	S1–S3m	N2a'	S2f	S3w	N1w	Root crops, papaya, milpa, beans
BF	Lower Belize Floodplains	502	High floodplain bench (h)	38	Limited cultivation, pasture	BV:Meditation + Morning Star > Bermudian Landing	1	(Wetness, nutrients)	3	S1–S2n	S2w	S3w	S1	S1	S3w	S3n	S3w	S1–S2n	S1–S2n	S2w	S1	S2d	S2m	S2m	N2z–	S2w	S1	S1	Citrus, rice
			Low floodplain bench backland (lb)	30	Very limited cultivation	BV:Bermudian Landing	3	Wetness, flooding	3	S3wf	S3wf	S3wf	S3f	S3w	S3wf	S3wf	S3wf	S3wf	S3w	S3wf	S1	S3f	S2f	S1	N2z–	S2f	S2f	S2w–N1w	Pasture, root crops, rice
			Low floodplain bench (l)	17	Very limited cultivation	BV:Lemonal > Freetown	1	Flooding	3	S3wf	S3wf	S3wf	S2f–S3f	S1>S3w	S3w	S3bw	S3w	S2f>S1	S1*>S3w	S2f>S3wf	S1	S3f	S2fm	S1	N2z–	S2f	S1>S2f	S1–N1w	Pasture, root crops, rice
			Alluvial wash (W)	9	Widespread cultivation	Sennis	2–3	Wetness, root room	4	S3wn–N2nr	S3wr–N2m	N1r–N2w	S3n–N1w	S2w	S3w–N2wn	N1n–N2b	S3wn	S2wn–N1w	S2w–N2nr	S3wn	S2m–S3w	S3wn–N1wn	S2n–N1m	S2n–N2r	N2z–	S2f–N1w	S3w	S2nr	Pasture, rice
			Gypsic high floodplain bench (gh)	4	Limited pasture	BV:gypsic Norland	3	Nutrients, (wetness)	3	S2n	S2wn	S3w	S2n	S2n	S3w	S3n	S3w	S2n	S2n	S2wn	S1	S2d	S2m	S2m	N2z–	S2wn	S2n	S1	Pasture, rice
			Low floodplain bench levee (ll)	1	Very limited housing	BV:Freetown	1	Flooding	2	S1	S1–S3w	S2w	S1–S3w	S1	S2w	S3b	S2w	S1	S1	S2w	S1	S3f	S2f	S1	N2z–	S2f	S1	S1	Citrus
			Gypsic low floodplain bench backland (glb)	1	Limited pasture	BV:gypsic Norland	4	Wetness, flooding, nutrients	3	S3wf	S3wf	S3wf	S3f	S3w	S3wf	S3wf	S3w	S3wf	S3w	S3wf	S1	S3f	S2f	S2n	N2z–	S2wf	S2f	S2w–N1w	Pasture, rice
			High floodplain bench backland (hb)	1	None	BV:Beaver Dam + Akalche	3	Wetness, flooding	3	S3wf	S3wf	S3wf	S3f	S3w	S3wf	S3wf	S3wf	S3wf	S3w	S3wf	S1	S3f	S2f	S1	N2z–	S2f	S2f	S2w–N1w	Pasture, root crops, rice
			Low terrace (lT)	0.4	None	Canquin?	1	(Nutrients, capping)	3	S2n	S2r–S3r	S3r	S1	S2r	S2r	S3r	S3n	S3nd	S2n	S2r–S3r	S1	S2d	S3m	S3m–N1m	N2z–	S2n	S2n	S1	Citrus
			High terrace (hT)	0.2	Very limited cultivation	BV:Duck Run	2	Drainage, root room	4	S3wn–N2nr	S3wr–N2m	N1r	S3n	S2r	S2r–N2n	N1n–N2b	S3nr	S3nr	N2nr	S2mn–S3mn	S2mk	S3n–N1n	S2m–N1m	S2n–N2r	N2z–	S3k	S3a*	S2nr	Pasture
			Stony terrace (sT)	0.1	Cultivation	BV:Central Farm	3	Root room	4	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N2m	N2z–	N1r	N1r	S3nq	None
BP	Belize Plain	438	Pitted plain (b)	26	None	BV:Hattieville + Double Head Cabbage	5	Nutrients, drainage, moisture	3 > 1	N2nr	N2n	N2r	N2nr>N1wn	S3wn–N2wn	N2wn	N2wn	N2wn	N2wn	N2nr	N1wn–N2wn	S3mn–N2wn	S3wn–N2w	S2nq–N2w	N2n	N2a'	N2wn	N2wn	S3nr>N2w(pine)	Pine
			Low plain (l)	21	None	Bocotora	5	Nutrients, drainage, moisture	3 > 1	N2nm	N2nr	N2nr>S3n	N2nr>N1nr	S3wn–N2wn	N2wn	N2wn	N2wn	N2wn	N2nr	N1wn–N2wn	S3n–N1n	N1wn>S3n	S3mn>N1mn	N2mn	N2a'>S3m	N2wn	N2wn	Pine: S3nr	Pine
			Redeposited old alluvial wash (pW)	16	None	Haciapina	4	Nutrients, drainage	3	N2wn	N2wn	N2w	N1wn	S3wn–N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N1wn–N2wn	S3wn	S3wn	S2nq–S3nq	N2mn	N2z–	N2wn	N2wn	S3w	Pine, pasture, rice
			High plain (h)	12	Road gravel borrowpits	BV:Colonel English + gravelly Santos Pine Ridge	5	Nutrients, moisture, root room	4	N2nr	N2nr	N1nr	N1nr	N1mn	N2mn	N2mn	N1mn	N1mn	N2mn	N1mn	S3mn–N1mn	N1mn	S3mn–N2nr	N2mn	N2z–	N1mn	N2mn	Pine: S3nr	Pine
			Undulating plain (U)	10	Road gravel borrowpits	BV:Rough Mile	5	Nutrients, moisture, root room	4	N2nr	N2nr	N2nr	N2nr	N2mn	N2mn	N2mn	N2mn	N2mn	N2mn	N2mn	S3mn–N1mn	S3wn	N1ms	N2mn	N2z–	N2mn	N2mn	Pine: S3nr	Pine
			Flat plain (N)	7	None	BV:Erindale > Rough Mile	4	Moisture, wetness, nutrients, root room	3 > 1	N2mn	N2mn	S3mn–N2r	N1mn–N2mn	S3mn–N2mn	N2mn	N2mn	S3mn	N2mn	N2mn	N1m–N2m	S3mn–N1wn	S3mn–N1mn	S3mn	N2mn	N2z–	N1mn–N2mn	N1mn–N2mn	S3r	Conservation
			Middle plain (m)	6	None	Bocotora > Crooked Tree	5 > 3	Nutrients, drainage, moisture	3 > 1	N2mn	N2n	N2nr>S2mn	N2nr>S3mn	S2mn–N2wn	N2wn>N1mn	N2n	N2wn>S3mn	N2wn>N1mn	N2n	N1m–N2wn	S2mn–N1n	N1wn>S3n	S3mn–N2w	N2mn	N2a'	N2wn>N1mn	N1mn–N2wn	Pine: S3nr	Pine
			Braided plain (a)	2	None	Bocotora?	5	Nutrients, drainage, moisture	2	N2wn	N2wn	N2w	N1wn–N2wn	S3wn–N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	S3mn–N2wn	S3wn–N2w	S2nq>N2w	N2n	N1a'	N2wn	N2wn	Pine: S3nr	Pine
			Very poorly drained basin (B)	1	None	Sibal	5	Wetness	2	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1kw–N2w	N2w	N1kw–N2w	N2w	N1a'	N2w	N2w	N2w	None
			Slightly undulating plain (SU)	0.4	None	SC:Regalia + Serpon	5 > 4	Nutrients, drainage, moisture	3 > 1	N2nr	N2nr	N2nr>S3n	N1nr–N2nr	S3mn–N2wn	N2wn	N2wn	N2wn	N2wn	N2nr	N1wn–N2wn	S3n–N1nr	N1wn>S3n	S3mn>N1mn	N2mn	N2z–	N1mn–N2wn	N1mn–N2wn	Pine: S3nr	Pine
BK	Beaver Dam Plain	336	Flat plain (N)	61	Very limited cultivation	BV:Beaver Dam	3	Workability, root room, wetness, nutrients	2	S2nk–N1w	N1w	N2w	N1wn	N1w	N2w	S3wn	N1w	S2kw–N1w	S1*–S3n	S3wn–N2w	S2w–S3w	N2wn	S1–N1s	S3mn–N2w	N2z–	S2kw–S3w	S3a*	S2w	Pasture
			Undulating plain (U)	30	Very limited cultivation	BV:Spanish Lookout	2	Workability, root room, moisture, nutrients	2	S2nk	S3m–N1mn	N2nr	N1mr>S3mn	S3mr	S3mn–N1m	S3mn	S2m	S2nk–S3k	S1–S3mn	S2mn–S3mn	S1–S2m	N1n	S3m–N1m	S3mn	N2z–	S1–S3k	S3a*	S1	Arable, pasture
			Lower slope (W)	8	None	BV:Akalche	4	Workability, root room, wetness, nutrients	2	N2w	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	S3n	S3w	N2z–	N2wn	N1wn–N2wn	S3w	Conservation
			Rolling plain (R)	0.3	None	BV:Piedregal + Chorro	3	Erosion, workability, root room, moisture	1	S2nk–S3ke	S3m–N1mn	N2nr	N1mr>S3mn	S3mr	N1m	S3m	S3ke	S3ke	N1e	S3me	S1–S2m	N1n	N2s	S3me	N2z–	S3ke	S3a*e	S1	Conservation
BZ	Belize River Plain	15		100	None	BV:Butcher Burns	4	Workability, root room, wetness, flooding	1	N2w	N2w	N2w	N2w	N1w	N2w	N2w	N2w	N2w	S3*wn	N2w	S3w	N2wn	S1–S3n	N2w	N2a'	N2w	N1w	S3w	Rice, conservation
LW	Cadena Creek Plain	159	Undulating plain (U)	59	None	BV:Beaver Dam	4	Workability, root room, wetness, nutrients	3 > 1	N2w	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	S1	S3w	N2z–	N2wn	N1wn–N2wn	S2w	Pasture
			Flat plain (W)	41	None	BV:Akalche	3	Workability, root room, drainage, nutrients	2	S2nk–N1w	N1w	N2w	N1wn	N1w	N2w	S3wn	N1w	S2kw–N1w	S1*–S3n	S3wn–N2w	S2w–S3w	N2wn	S1–N1s	S3mn–N2w	N2z–	S2kw–S3w	S3a*	S3w	Rice

NORTHERN COASTAL PLAIN (cont.)

	Land system[1]	Area (km²)	Main subunits[2]	Percentage area within land system	Current land use	Main soil types	Agricultural Value	Main limiting factors[3]	Conservation Value	Land suitability: Beans	Cacao	Cashew	Citrus	Coconuts	Coffee (Robusta)	Cotton	Groundnuts	Maize (mechanised)	Milpa (shifting cultivation)	Papaya	Pasture	Pineapple	Rice (mechanised)	Root crops	Shrimps	Sorghum	Sugar-cane	Timber	Provisional recommendations
CZ	Round Hole Plain	68	Undulating plain (U)	85	None	BV:Piedregal + Chorro + Tambos	3	Workability, root room, moisture, nutrients	2	S2nk-S3k	S3m-N1mn	N2nr	N1mr>S3mn	S3mr	N1m	S3mn	S3mk	S2nk-S3k	S2mn-S3n	S2mn-S3mn	S1-S2m	N1n	N1ns	S3mn	N2z-	S2m-S3k	S3a*	S1	Timber, pasture, maize, beans
			Flat plain (N)	9	None	BV:Chorro	3	Workability, root room, moisture, nutrients	2	S2nk-S3k	S3m-N1mn	N2nr	N1mr>S3mn	S3mr	N1m	S3mn	S3mk	S2nk-S3k	S2mn-S3n	S2mn-S3mn	S1-S2m	N1n	N1ns	S3mn	N2z-	S2m-S3k	S3a*	S1	Timber, pasture, maize, beans
			Rolling plain (R)	3	None	BV:Piedregal	4	Erosion, workability, root room, moisture	2	S2nk-S3ke	S3m-N1mn	N2nr	N1mr>S3mn	S3mr	N1m	S3me	S3ke	S3ke	N1e	S3me	S1-S2m	N1n	N2s	S3me	N2z-	S3ke	S3a*e	S1	Pasture
			Steep slope (S)	3	None	BV:Piedregal	5	Erosion, workability, root room, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z-	N2e	N2e	N2e	Conservation
LK	Spanish Lookout Plain	208	Undulating plain (U)	91	Limited cultivation	BV:Spanish Lookout + Beaver Dam	2-3	Workability, root room, moisture, nutrients	2 > 4	S2nk-N1w	S3m-N1mn	N2nr	N1mr>S3mn	S3mr	S3mn-N1m	S3wn-N1kw	S2m-N1w	S2nk-N1w	S2mn-S3n	S2mn-S3mn	S1-S3w	N1n>N2w	S1-N1m	S3mn-N2w	N2z-	S1-N1w	S3a*	S1	Arable, pasture
			Floodplain (F)	6	None	BV:Iguana	4	Drainage	2	S2wn-N1w	N1w	N2w	N1wn	S3w	N2wn	S2wn	N1wn	S2wn-S3wn	S1*-S3wn	S2wn-N1w	S1-S2n	N1wn-N2wn	S1-S3n	S1-N2w	N2z-	S2w	S1-S3wn	S3w	Rice
			Moderately sloping valley (R)	3	Cultivation	BV:Spanish Lookout	2	Erosion, workability, root room, moisture	1	S2nk-S3ke	S3m-N1mn	N2mr	N1mr>S3me	S3me	S3mn-N1m	S3ne-N1k	S3e	S3e	N1e	S3me	S3e	N1n	N2s	S3me	N2z-	S3ke	S3a*e	S1	Conservation
			Lower slope (W)	1	None	BV:Akalche	4	Workability, root room, wetness, nutrients	2	N2w	N2wn	N2wn	N2wn	N1wn-N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N1wn-N2wn	N2wn	S3m	S3w	N2z-	N2wn	N1wn-N2wn	S3w	Conservation
			Steep slope (S)	0.05	None	BV:Piedregal	5	Erosion, workability, root room, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z-	N2e	N2e	N2e	Conservation
CK	Belmopan Plain	171	Undulating plain (U)	86	Widespread cultivation	BV:Camelote + Society Hall	2-3	Workability, moisture, nutrients	3-4	S3m-N1k	S3m-N1m	N1mr	S3mn-N1mn	S3n	S2mn-S3mn	N1k	N1mn	N1k	S2mn-N1mn	S3mn-N1mn	S2mk	S2n-N1n	N1mk-N2mk	S3mn	N2z-	S3k	S3m-N1m	S1	Timber, pasture
			Lower slope (W)	7	Limited cultivation	BV:Society Hall > Cadena Creek	3	Workability, nutrients, wetness	2	S2nk-N1w	S3w	N1w	N1wn	N1w	N1w	N1k	N1wn	N1k	S2n-N1n	S3wn-N2w	S2k-S3w	N2wn	N1k-N2k	S3mn-N2w	N2z-	S3k	S3a*	S2w	Conservation
			Flat plain (N)	4	None	BV:Society Hall	3	Workability, nutrients, drainage	2	S2nk-N1w	S2w	S3w	S3n-N1n	S3n	S2n-S3n	N1k	N1n	N1k	S2n-N1n	S3n-N1n	S2k	S2n-N1n	N1k-N2k	S3n	N2z-	S3k	S3a*	S1	Timber, pasture, cacao
			Low karst (LK)	2	Very limited milpa	BV:Mount Hope + Camelote + Society Hall	3-5	Workability, moisture, nutrients, erosion	1-2	S3m-N2e	S3m-N2e	N1mr-N2e	S3mn-N2e	S3n-N2e	S2mn-N2e	N1k-N2e	N1mn-N2e	N1k-N2e	S2mn-N2e	S3mn-N2e	S2mk>N2e	S2n-N2e	N1nk-N2s	S3mn>N2e	N2z-	S3k>N2e	S3m-N2e	S1>N2e	Conservation, smallholder farming on footslopes
			Rolling plain (R)	1	Limited cultivation	BV:Mount Hope	4	Workability, root room, moisture, nutrients	1	S3me-N1k	S3me-N1m	N1mr	S3me-N1mn	S3ne	S3me	N1k	N1mn	N1k	N1me	S3me-N1mn	S2mk	S2n-N1n	N2s	S3me	N2z-	S3ke	S3a*e	S1	Conservation
			Steep slope (S)	0.06	None	BV:Mount Hope	5	Erosion, workability, root room, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z-	N2e	N2e	N2e	Conservation
			Medium karst (MK)	0.06	None	BV:Mount Hope	5	Erosion, workability, root room, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z-	N2e	N2e	N2e	Conservation
CF	Cayo Floodplains	127	Calcareous high floodplain bench (ch)	34	Very limited pasture	Quemina > Canquin + BV:Hattieville	2-4	Nutrients, drainage, moisture	3 > 1	S2n-N2mn	S2m-N2mn	S3wr-N2r	S1-N2mn	S1-N2mn	S1-N2mn	S2n-N2mn	S3n	S1-N2mn	S1*-S2mn	S2n-N2m	S1-N1wn	S2nd-N1mn	S3m>S2m	S1-S3mn	N2z-	S2mn-N2mn	S3a*-N2mn	S1	Citrus, pasture, timber
			High floodplain bench (h)	26	Widespread cultivation, pasture	Canquin > Quemina	1	(Capping, nutrients)	4	S2n	S2r-S3r	S3r	S1	S1	S2r	S3n	S3n	S3nd>S1	S1*	S2r-S3r	S1	S2d	S3m>S2m	S3m-N1m	N2z-	S2n	S3a*	S1	Citrus, pasture
			Low floodplain bench (l)	24	Widespread cultivation, pasture	Monkey River	1	(Flooding)	4	S1	S3wf	S3wf	S2f	S2r>S1	S3w	S3rb>S2nb	S3w	S1-S2f	S2r>S1	S2f	S1	S3f	S2fm	S1	N2z-	S2f	S3a*	S2w-N1w	Citrus, rice, pasture
			Terrace (T)	10	Widespread cultivation, pasture	Canquin + stony Canquin > Quemina	2	Root room, (nutrients)	4	S2nr	S3r>S2r	S3r	S1-S2r	S2r	S2r	S3rb	S3nr	S3nd	S1	S2r-S3r	S1	S2r	S3m	S3m-N1m	N2z-	S2nr	S3a*	S1	Citrus, pasture, timber
			Calcareous terrace (cT)	5	Very limited pasture	Quemina + BV:Hattieville	2-4	Nutrients, drainage, moisture	3 > 1	S2n-N2mn	S2m-N2mn	S3w-N2r	S1-N2mn	S1-N2mn	S2r-N2mn	S2bn-N2mn	S3wn	S1-N2mn	S1*-N2mn	S2n-N2m	S1-N1wn	S2n-N1mn	S2m-S3mn	S1-S3mn	N2z-	S2m-N2mn	S3a*-N2mn	Sl	Citrus, pasture, timber
			Calcareous low floodplain bench (cl)	2	None	Quemina > Monkey River	1	(Flooding)	4	S2n>S1	S2m-S3wf	S3wf	S2f	S1	S3w	S2bn	S3w	S1-S2f	S1*	S2f	S1	S3f	S2fm	S1	N2z-	S2f	S3a*	S1-N1w	Citrus, pasture
IF	Upper Belize Floodplains	101	High floodplain bench (h)	41	Cultivation	BV:Redbank	1	(Capping, nutrients)	4	S1-S2n	S2r-S3r	S3r	S1	S2r	S2r	S3r	S3n	S3nd	S2n	S2r-S3r	S1	S2d	S3m	S2m-N1m	N2z-	S2n	S3a*	S1	Citrus, pasture
			Low floodplain bench (l)	19	Cultivation	BV:Quamina	1	(Flooding)	4	S1	S3wf	S3wf	S2f	S1	S3w	S3n	S3w	S1-S2f	S1*	S2f	S1	S3f	S2fm	S1	N2z-	S2f	S3a*	S2w-N1w	Citrus, rice, pasture
			Dissected terrace (dT)	17	Cultivation	BV:Listowel + Esperanza	1	Root room, fragmentation, (nutrients)	4	S1-S2r	S2r-S3r	S3r	S1	S2r	S2r	S3rb	S3n	S3nb	S2n	S2r-S3r	S1	S2d	N1mb	N1m	N2z-	S2n	S3a*b	S1	Citrus, pasture
			Gravelly old terrace (pT)	9	None	BV:Gravelly Santos Pine Ridge + Kaway + Akalche	4	Nutrients, root room, drainage, moisture	3 > 1	S3wn-N2n	S3wr-N2mn	S3mn-N2r	S3n-N2mn	S2r-N2mn	S2r-N2n	N1n-N2bm	S3n	S3nr-N2mn	N2nr	S3mn-N2m	S2mk-N1wn	S3mn-N1mn	S2m-N1m	S2n-N2r	N2z-	S3k-N2mn	S3a*-N2mn	S3nr	Pasture, pine
			Old terrace (p)	7	None	BV:Hattieville	4	Nutrients, drainage, moisture	3 > 1	N1mn-N2mn	N2mn	S3mn-N2r	N1mn-N2mn	S3mn-N2mn	N2mn	N2mn	S3mn	N2mn	N2mn	N1m-N2m	S3mn-N1wn	S3mn-N1mn	S3mn	S3mn	N2z-	N1mn-N2mn	N1mn-N2mn	Pine: S3nr	Pine
			Terrace (T)	5	None	BV:Willows Bank + Duck Run	2	Drainage, root room	4	S3wn-N2nr	S3wr-N2m	N1r	S3n	S2r	S2r-N2n	N1n-N2b	S3nr	S3nr-	N2nr	S2mn-S3mm	S2mk	S3n-N1n	S2m-N1m	S2n-N2r	N2z-	S3k	S3a*	S2nr	Pasture
			Hillock (R)	2	Limited pasture	BV:Listowel + Esperanza > Mount Hope	4	Root room, fragmentation, (nutrients)	1	S3me-N1k	S3me-N1m	N1mr	S3me	S3e	S3e	S3be>N1k	S3ne>N1mn	S3be>N1k	N1e	S3e>N1mn	S1>S2mk	S2d-N1n	N2s	N1m>S3me	N2z-	S3e	S3a*b	S1	Conservation
			Undulating plain (U)	0.05	Limited pasture	BV:Morning Star	1	(Capping, nutrients)	4	S1-S2n	S2r-S3r	S3r	S1	S2r	S2r	S3r	S3n	S3nd	S2n	S2r-S3r	S1	S2d	N1s	S2m-N1m	N2z-	S2n	S3a*	S1	Citrus, pasture

Land system①		Area (km²)	Main subunits②	Percentage area within land system	Current land use	Main soil types	Agricultural Value	Main limiting factors③	Conservation Value	Beans	Cacao	Cashew	Citrus	Coconuts	Coffee (Robusta)	Cotton	Groundnuts	Maize (mechanised)	Milpa (shifting cultivation)	Papaya	Pasture	Pineapple	Rice (mechanised)	Root crops	Shrimps	Sorghum	Sugar-cane	Timber	Provisional recommendations
BRAVO HILLS																													
OA	Albion Island Plain with Hills	23	Undulating plain (U)	62	Limited sugar-cane	Yalbac	2–3	Workability, root room, moisture, nutrients	4	S2nk	S3m–N1mn	N2nr	N1mr>S2mn	S3mr	S3mn	S3mn	S2m	S2nk–S3k	S1–S2mn	S2mn–S3mn	S1–S2m	N1n	S3m–N1m	S3mn	N2z–	S1–S3k	S1–S2mn	S1	Arable, pasture
			Rolling plain (R)	23	Limited sugar-cane	Shallow Yalbac > Chacluum	4	Erosion, workability, root room, moisture	1	S2nk–S3ke	S3m–N1m	N2mr>N1mn	S2n–N1nr	S3mr–N1mn	N1m	S3me>N1mn	S3ke	S3e	N1w	S3e	S1–S3mn	N1n>S3e	N2s	S3me	N2z–	S3e	S3e	S1	Conservation
			Steep slope (S)	6	None	Shallow Yalbac	5	Erosion, workability, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Swamp (-⫫-)	7	None	Sibal	5	Wetness	3	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1kw	N2w	N1kw	N2w	N2z–	N2w	N2w	N2w	None
NH	Blue Creek Plain	129	Low marsh forest plain (W)	53	Very limited pasture	Jolja + shallow Yalbac + Chucum	4	Workability, root room, drainage	3 > 1	S2nk–N1w	N1wn>N2wn	N2rw	S3mn–N2wn	S3n–N2wn	S3nr–N2w	S3wn–N2kn	S2m–N2wn	S2k–N2wn	S1*–N2wn	S3wn–N2w	S2wn–N2wn	N1n–N2w	S1–N2mn	S3mn–N2w	N2z–	S2kw–N2wn	S2w–N2wn	N1w	Rice, groundnuts, maize, pasture
			Undulating plain (U)	34	Very limited pasture, maize	Jolja + Yalbac	3	Workability, moisture	2	S2nk–N1km	N1mn>S3m	N2mr	S3mn–N1mn	S3nr–N1nr	S3nr–N2mn	S3mn–N2kn	S2m–N1km	S2nk–N1km	S1–N1mn	S2mn–N1mn	S1–S3k	S3mn–N2wn	S3km	S3mn–N1rk	N2z–	S1–N1k	S1–S3km	S1	Pasture
			Marsh forest plain (h)	12	None	Pucte	4	Wetness	2	N2w	N2w	N2w	N2w	N1w>S3w	N1w–N2w	N2w	N2w	N2w>N1w	S3*wn>S2*wn	N2w>N1w	S3w>S2w	N1wn	S2n–S3n	S3w–N2w	N2z–	N2w>S3w	S3w–N1w	S3w	Rice
NK	Neustadt Plain	288	Undulating plain (U)	84	Limited pasture, milpa, sorghum	Jolja > Yalbac	3	Workability, moisture	2	S2nk–N1km	N1mn>S3m	N2mr	S3mn–N1mn	S3nr–N1nr	S3nr–N2mn	S3mn–N2kn	S2m–N1km	S2nk–N1km	S1–N1mn	S2mn–N1mn	S1–S3k	S3mn–N2wn	S3km	S3mn–N1rk	N2z–	S1–N1k	S1–S3km	S1	Conservation, pasture
			Lower slope (W)	8	Very limited pasture	Jolja + Chucum > Mottled Yalbac	3–4	Workability, drainage	2	S3k–N2w	N1n–N2wn	N2rw	S3n–N2wn	S3n–N2wn	S3nr–N2wn	S3wn–N2wn	S3k–N2wn	S2kw–N2wn	S1*–N2wn	S3wn–N2wn	S2kn–N2wn	N1n–N2wn	S3km–N2mn	S3mn–N2w	N2z–	S2kw–N2wn	S2w–N2wn	S3w–N2w	Conservation, pasture
			Rolling plain (R)	7	Very limited pasture	Jolja > Yalbac	4	Erosion, workability, moisture	1	N1ke	N1mn	N2mr	S3mn–N1mn	S3nr–N1nr	S3nr–N2mn	N1kn–N2kn	N1km	N1ke	N1ne	N1mn	S2kn–S3k	S3ne–N2n	N2s	N1rk	N2z–	S3k–N1k	S3km	S1	Conservation, pasture
			Steep slope (S)	1	None	Jolja > Yalbac	4	Erosion, workability, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
OD	Neuendorf Escarpment	10	Steep slope (S)	85	None	Shallow Yalbac > Jolja	5	Erosion, workability, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Dissected terrace (dT)	6	Limited cultivation	Pasmore	2	Access, nutrients	3	S3a	S3a	S3ra	N1n	S3a	N2n	S3a	N1n	S3a	S1–S3n	S3a	S1–S2n	N1n–N2n	S3ma	S1	N2z–	S3a	S3a	S3a	Conservation
			Moderately sloping valley-side slope (R)	5	None	Shallow Yalbac > Jolja	4	Erosion, workability, moisture	1	N1ke	S3m–N1mn	N2mr	N1nr	S3ma–N1nr	S3nr–N2mn	S3ma–N2kn	S3mk>N1km	N1e	N1e	S3mn>N1mn	S1–S3k	N1n>N2n	N2s	N1rk	N2z–	S3ak>N1k	S3ak	S3a	Conservation
			Floodplain (F)	4	Limited cultivation	Pasmore	3	Access, nutrients, wetness	3	S3a	N1w	N2w	N1wn	S3aw	N2wn	S3a	N1wn	S3a	S1–S3wn	S3a–N1w	S1–S2n	N1wn–N2wn	S3ma	S1	N2z–	S3a	S3a	S3a	Conservation
NW	Neustadt Swamps	48	Open savanna plain (I)	54	Very limited pasture	Chucum > Sibal	4	Workability, root room, wetness, nutrients	2	N2w	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	S3mn	S3w	N2z–	N2wn	N1wn–N2wn	N2w	None
			Low marsh forest plain (m)	39	None	Chucum > Sibal	4	Workability, root room, wetness, nutrients	2	N2w	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	S3mn–N2mn	S3w	N2z–	N2wn	N1wn–N2wn	N2w	None
			Marsh forest plain (h)	6	None	Chucum > Sibal	4	Workability, root room, wetness, nutrients	3 > 1	N2w	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N2wn	N1wn–N2wn	N2wn	S3mn–N2mn	S3w	N2z–	N2wn	N1wn–N2wn	N2w	Conservation
			Undulating plain (U)	0.2	None	Chucum > Sibal	4	Workability, root room, wetness, nutrients	3 > 1	N2n	N2n	N2n	N2n	N1n–N2n	N2n	N2n	N2n	N2n	N2n	N2n	N1n–N2n	N2n	N1mn–N2mn	S3mn	N2z–	N2n	N1n–N2n	S3w	None
OX	Gallon Jug Plain with Hills	1051	Undulating plain (U)	58	Very limited cultivation	Yalbac	2–3	Workability, root room, moisture, nutrients	1	S2nk	S3m–N1mn	N2nr	N1mr>S3mn	S3mr	S3mn	S3mn	S2m	S2nk–S3k	S1–S2mn	S2mn–S3mn	S1–S2mn	N1n	S3m–N1m	S3mn	N2z–	S1–S3k	S1–S2mn	S1	Conservation, arable, pasture
			Rolling plain (R)	29	None	Shallow Yalbac > Chacluum	4	Erosion, workability, root room, moisture	1	S2nk–S3ke	S3m–N1mn	N2mr>N1mn	S2n–N1nr	S3mr>N1mn	S3mn–N1m	S2mn–N1m	S3ke	S3e	N1e	S3ne	S1–S2m	S2n–N1n	N2s	S3me	N2z–	S3e	S3e	S1	Conservation
			Lower slope (W)	5	None	Mottled Yalbac + Pucte + Chucum?	3–4	Workability, root room, drainage, nutrients	1	N1w–N2w	N1w–N2w	N2w	N1wn–N2w	N1w	N1w–N2w	N1kw–N2w	N1w–N2w	S2kw–N2w	S1*–S3*wn	S3wn–N2w	S2w–S3w	N1wn–N2wn	S1–S3n	S3w–N2w	N2z–	S2kw–N2w	S2w–N1w	S3w	Conservation
			Low karst (LK)	5	None	Yalbac + Shallow Yalbac > Chacluum	2–5	Erosion, workability, moisture	1	S2nk>N2e	S3m–N2e	S3m–N2e	S3mn–N2e	S3mr>N2e	S3mn–N2e	S3mn>N2e	S2m>N2e	S2nk–N2e	S2mn>N2e	S3mn>N2e	S2m>N2e	N1n–N2e	N1m–N2s	S3mn>N2e	N2z–	S1–N2e	S2mn>N2e	S1>N2e	Conservation
			Steep slope (S)	1	None	Shallow Yalbac > Chacluum	5	Erosion, workability, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Medium karst (MK)	1	None	Shallow Yalbac > Chacluum	5	Erosion, workability, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
OQ	Yalbac Dissected Cuesta	45	Moderately sloping valley (V)	50	None	BV:Piedregal	4	Workability, root room, moisture, nutrients	1	S2nk–S3ke	S3m–N1m	N2mr	N1nr	S3mr	N1m	S3me	S3ke	S3ke	N1e	S3me	S1–S2m	N1n	N2s	S3me	N2z–	S3ke	S3e	S1	Conservation
			Undulating plateau (π)	30	None	BV:Piedregal	3	Workability, root room, moisture, nutrients	1	S2nk–S3k	S3m–N1m	N2mr	N1nr	S3mr	N1m	S3mn	S3mk	S2m–S3k	S2m	S3mn	S1–S2m	N1n	N1ms	S3mn	N2z–	S2n–S3k	S2e	S1	Conservation
			Steep slope (S)	20	None	BV:Piedregal	5	Erosion, workability, root room, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
LX	Pilar Camp Hills	57	Rolling Plain (R)	54	Limited cultivation	BV:Piedregal	4	Workability, root room, moisture, nutrients	2	S2nk–S3ke	S3m–N1m	N2mr	N1nr	S3mr	N1m	S3mn	S3mk	S2m–S3ke	S2m	S3me	S1–S2m	N1n	N2s	S3me	N2z–	S2m–S3k	S3e*	S1	Pasture
			Undulating plain (U)	30	Widespread cultivation	BV:Piedregal + Chorro + Tambos	3	Workability, root room, moisture, nutrients	4	S2nk–S3k	S3m–N1m	N2mr	N1nr	S3mr	N1m	S3mn	S3mk	S2m–S3k	S2m	S3mn	S1–S2m	N1n	N1ms	S3mn	N2z–	S2m–S3k	S3e*	S1	Pasture, maize, beans
			Steep slope (S)	15	Very limited cultivation	BV:Piedregal	5	Erosion, workability, root room, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Low karst (LK)	1	Limited cultivation	BV:Piedregal + Chorro	3–5	Erosion, workability, root room, moisture	1	S2nk–N2e	N1m–N2e	N2me	N1nr–N2e	S3mr–N2e	N1m–N2e	S3mn–N2e	S3mk–N2e	S2m–N2e	S3m–N2e	S3mn–N2e	S1–N2e	N1n–N2e	N1ms–N2ms	S3mn–N2e	N2z–	S2m–N2e	S3e*–N2e	S1>N2e	Conservation

	Land system[1]	Area (km^2)	Main subunits[2]	Percentage area within land system	Current land use	Main soil types	Agricultural Value	Main limiting factors[3]	Conservation Value	Land suitability: Beans	Cacao	Cashew	Citrus	Coconuts	Coffee (Robusta)	Cotton	Groundnuts	Maize (mechanised)	Milpa (shifting cultivation)	Papaya	Pasture	Pineapple	Rice (mechanised)	Root crops	Shrimps	Sorghum	Sugar-cane	Timber	Provisional recommendations
CENTRAL COASTAL PLAIN																													
TY	Belize Saline Swamps	105	Low tidal flat (l)	98	None	Ycacos	5	Wetness, salinity	1	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	S2k> N1p	N2wz	N2wz	N2wz	Conservation
			High tidal flat (h)	2	None	Ycacos + Hopkins	4	Wetness, salinity	4	N2z	N2z	S2m–N2wz	N2z	S1	N2z	N2z	N2z	N2bz	N2z	N2z	N2bz	S3m–N2wz	N2z	N2z	S3m	N2z	N2z	N1z–N2wz	Tourism
BW	Belize Swamps	76	Herbaceous swamp (l)	40	None	Subal > Ycacos	5	Wetness, salinity	1	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	S1> N1p	N2wz	N2wz	N2wz	Conservation, shrimp mariculture
			Glady marsh forest (H)	34	None	Sibal > Ycacos	5	Wetness, salinity	1	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	S3k> N1p	N2wz	N2wz	N2wz	Conservation
			Marsh forest (h)	14	None	Sibal	5	Wetness	2	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1a'	N2w	N2w	N2w	Conservation
			Mangrove (M)	12	None	Ycacos	5	Wetness, salinity	1	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	N2wz	S2k> N1p	N2wz	N2wz	N2wz	Conservation
TB	Toledo Strand Plain	0.3		100	None	Hopkins + Ycacos + Sibal	3-5	Moisture, wetness, salinity	4	N2mw	N2mw	N2w> S2m	N2mw	N1w> S3m	N2mw	N2mw	N2mw	N2mw	N2mw	N2mw	S3m–N2w	S3m N2w	N2mw	N2mw	S1–S3m	N2mw	N2mw	N1z–N2wz	Tourism
SB	Stann Creek Strand Plain	0.7		100	None	Hopkins	3	Moisture	1	N2m	N2m	S2m	N2m	S3m	N2m	N2m	N2m	N2m	N2m	N1m	S3m	S3m	N2m	N2m	S3m	N1m	N2m	N1z	Tourism
TP	Puletan Plain	38	Flat plain (N)	53	None	SC:Savannah + Bladen	5	Nutrients, drainage, moisture	3 > 1	N2nr	N2nr	N2nr> N1nr	N2nr> N1nr	N2nr> N1nr	N2nr> N1nr	N2nr> N1nr	N2mn> N1mn	N2nr	N2nr	N2nr	S3n–N1nr	N1wn> N2wn	S3mn> N1mn	N2mn	S1	N2nr	N2mn	Pine: S3nr	Pine
			Saline plain (sl)	39	None	Buttonwood	5	Nutrients, drainage, salinity	3 > 1	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	N2nz	S1	N2nz	N2nz	N2nz	Shrimp mariculture
			Pitted plain (b)	7	None	Puletan	5	Nutrients, drainage, moisture	3 > 1	N2nr	N2nr	N2nr> N1nr	N2nr	N2nr	N2nr	N2nr	N2mn	N2nr	N2nr	N2nr	S3n–N2w	N1wn–N2w	S3mn–N2w	N2mn	S1	N2nr	N2mn	Pine:S3nr–N2w	Pine
			Very poorly drained basin (B)	1	None	Sibal	5	Wetness	2	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1kw–N2w	N2w	N1kw–N2w	N2w	S1	N2w	N2w	N2w	None
SM	Matamore Strand Plain	0.6		100	None	Matamore	3	Moisture	4	N2mn	N2mn	S1	S2mn–S3mn	S2mn	N2mn	N1mr	N1mn	N2mn	N2mn	S3m	S3m	S2mn	N2m	N2m	S3m	S3mn	N1m	S3n	Cashew, pineapples, cassava
SF	Stann Creek Coastal Floodplains	2	Low floodplain bench (l)	100	None	Monkey River	1	(Flooding)	3 > 1	S1	S3wf	S3wf	S2f	S1	S3w	S3n	S3w	S1–S2f	S1*	S2f	S1	S3f	S2f	S1	N2z–	S2f	S3a*	S2w–N1w	Rice, pasture
CENTRAL FOOTHILLS																													
IK	Ramonal Hills	59	Undulating plain (U)	71	Widespread cultivation	BV:Shallow Tambos	3	Workability, root room, moisture, nutrients	4	S2m–S3k	N1m	N2mr	N1nr	S3mr	N1m	S3mn	S3mk	S2m–S3k	S2m	S3mn	S1–S2m	N1n	N1m	S3mn–N2w	N2z–	S2m–S3k	S3a*	S1	Pasture, maize, beans
			Rolling plain (R)	28	Limited cultivation	BV:Piedregal + shallow Tambos	4	Workability, root room, moisture, nutrients	2	S2nk–S3ke	N1m	N2mr	N1nr	S3mr	N1m	S3mn	S3mk	S2m–S3ke	S2m	S3me	S1–S2m	N1n	N2s	S3mn	N2z–	S2m–S3k	S3a*	S1	Pasture
			Low karst (LK)		Limited cultivation	BV:Piedregal + shallow Tambos	3-5	Erosion, workability, root room, moisture	1	S2nk–N2e	N1m–N2e	N2me	N1nr–N2e	S3mr> N2e	N1m–N2e	S3mn> N2e	S3mk> N2e	S2m–N2e	S2m> N2e	S3mn> N2e	S2m> N2e	N1n–N2e	N1ms–N2s	S3mn> N2e	N2z–	S2m–N2e	S3a*> N2e	S1> N2e	Conservation
			Steep slope (S)	0.3	None	BV:Piedregal	3	Erosion, workability, root room, moisture	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
BX	Hummingbird Plain with Hills	201	Medium karst (MK)	37	None	Cabro > (Xpicilha + San Lucas + Quamina)	5 > 2	Erosion, shallow soils	1	N2e> S3mq	N2e> S2mw	N2wm> S2w	N2e> S3m	N2e> S3n	N2e> S3m	N2e> S3nb	N2e> S3k	N2e> S3m	N2e> S2mn	N2e> S3m	N2e> S1	N2e> S3m	N2s> S2k	N2e> S1	N2z–	N2e> S3q	N2e> S3a*	N2e> S1	Conservation, smallholder farming on footslopes
			Flat alluvial plain (N)	23	Very limited milpa	Quamina > (Puletan + Canquin)	2 > 5	Variability	3 > 1	S1–N2nr	S2r–N2nr	S2w–N2nr	S1–N2nr	S2n–N2nr	S2r–N2nr	S2n–N2nr	S2n–N2wr	S2n–N2nr	S1*–N2nr	S2n–N2nr	S1–N1nr	S2n–N2wn	S2k–N2m	S1–N2mn	N1a'z–N2a'z–	S2m–N2nr	S3a*–N2nr	S1-S3nr (pine)	Mixed smallholder farming
			Low karst (LK)	22	Very limited milpa	Cabro + Quamina > (Xpicilha + San Lucas)	2-5	Erosion, shallow soils, variability	3 > 1	S1–N2e	S2r–N2e	S2w–N2e	S1–N2e	S2n–N2e	S2r–N2e	S2n–N2e	S2n–N2e	S2n–N2e	S1*–N2e	S2n–N2e	S1–N2e	S2n–N2e	S2k–N2e	S1–N2e	N1a'z–N2a'z–	S2m–N2e	S3a*–N2e	S1–N2e	Conservation, smallholder farming on footslopes
			Slightly undulating plain (SU)	17	None	SC:Regalia + Serpon > Quamina	5 > 2	Nutrients, drainage, moisture	3 > 1	N2nr> S1	N2nr> S3m	N2nr> S3w	N2nr> S1	N2nr> S2n	N2nr> S3rb	N2nr> S2r	N2nr> S2n	N2nr> S2n	N2nr> S1*	N2nr> S2n	S3n> S1	M1wn> S2n	S3mn> S2k	N2mn> S1	N1a'z–N2a'z–	N2nr> S2m	N2nr> S3a*	Pine: S3n>S1	Pine
			Very poorly drained basin (B)	1	None	Sibal	5	Wetness	2	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N2w	N1kw–N2w	N2w	N1kw–N2w	N2w	N2a'	N2w	N2w	N2w	None
			Pitted alluvial plain (b)	0.5	None	Puletan > Quamina	5	Nutrients, drainage, moisture	3 > 1	N2nr> S1	N2nr–S3m	N2nr> S3w	N2nr> S1	N2nr> S2n	N2nr> S3r	N2nr> S2r	N2nr–S2n	N2nr> S2n	N2nr> S1*	N2nr> S2n	S3n> S1	N1wn> S2n	S3mn	N2mn> S1	N1a'z–N2z–	N2nr> S2m	N2nr> S3a*	Pine: S3n–N2w	Pine
			High karst (HK)	0.2	None	Cabro	5	Erosion, shallow soils	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
IZ	Hermitage Plain	28	Undulating plain (U)	79	Widespread cultivation	BV:Tambos > Piedregal	3	Workability, root room, moisture, nutrients	4	S2nk–S3k	S3m–N1m	N2mr	N1nr	S3mr	S3m	S3mn	S3mk	S2m–S3k	S2m	S3mn	S1–S2m	N1n	N1ms	S3mn–N2w	N2z–	S2m–S3k	S3a*	S1	Pasture, maize, beans
			Rolling plain (R)	21	Widespread cultivation	BV:Piedregal > Tambos	4	Workability, root room, moisture, nutrients	3	S2nk–S3k	S3m–N1m	N2mr	N1nr	S3mr	S3mn	S3mn	S3mk	S2m–S3k	S2m	S3mn	S1–S2m	N1n	N2s	S3mn	N2z–	S2m–S3k	S3a*	S1	Pasture
			Low karst (LK)	0.4	Limited cultivation	BV:Tambos + Piedregal	3-5	Erosion, workability, root room, moisture	1	S2nk–N2e	S3m–N2e	N2me	N1nr–N2e	S3mr–N2e	N1m–N2e	S3mn> N2e	S3mn> N2e	S2m–N2e	S2m> N2e	S3mn> N2e	S2m> N2e	N1n–N2e	N1ms–N2s	S3mn> N2e	N2z–	S2m–N2e	S3a*> N2e	S1–N2e	Conservation, smallholder, farming on footslopes

Land system[1]		Area (km²)	Main subunits[2]	Percentage area within land system	Current land use	Main soil types	Agricultural Value	Main limiting factors[3]	Conservation Value	Land suitability																			Provisional recommendations
										Beans	Cacao	Cashew	Citrus	Coconuts	Coffee (Robusta)	Cotton	Groundnuts	Maize (mechanised)	Milpa (shifting cultivation)	Papaya	Pasture	Pineapple	Rice (mechanised)	Root crops	Shrimps	Sorghum	Sugar-cane	Timber	
WESTERN UPLANDS																													
TX	Xpicilha Hills with Plains	1275	Medium karst (MK)	27	None	Chacalte > Cuxu	5	Erosion, shallow soils	1	N2e>S3mq	N2e>S2w	N2em	N2e>S3m	N2e>S3n	N2e>S3m	N2e>S3nb	N2e>S3k	N2e>S3m	N2e>S2m	N2e>S3m	N2e>S1	N2e>N1mn	N2s	N2e>S1	N2z-	N2e>S3q	N2e>S3ka*	N2e>S1	Conservation
			High karst (HK)	26	None	Cabro	5	Erosion, shallow soils	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z-	N2e	N2e	N2e	Conservation
			Undulating plain (U)	15	Widespread milpa	San Lucas + Xpicilha	3	Drainage, shallow soils	3	S2kw-S3mq	S2mw-N1mw	N1w-N2mw	S3mw-N1mw	S3n-N1w	S3m-N1mw	S3nb-N1wn	S3kw-N1mq	S2kw-S3mq	S2mn-N1m	S2w-N1mn	S1-S3q	S3w-N1n	S2m-N2mq	S1-N2m	N2z-	S2kw-S3qn	S3a*n	S1	Timber, pasture, maize sorghum
			Undulating plain with low karst (UKL)	9	Very limited milpa	Chacalte > Cuxu	4-5	Shallow soils, variability, erosion	3 > 1	S2kw-N2me	S2w-N2me	N2me>N1mr	S3m-N2me	N1c>N2me	S2mn-N2e	S3nb-N2me	S3kw-N2me	S2kw-N2me	S2mn-N2ne	S2w-N2me	S1-N2me	S3n-N2ne	N2ms	S1-N2e	N2z-	S2kw-N2me	S3a*-N2me	S1>N2e	Timber, conservation
			Low karst (LK)	7	Very limited milpa	Chacalte	4-5	Shallow soils, variability, erosion	3 > 1	S2kw-N2me	S2w-N2me	N1w-N2me	S3mw-N2me	S3n>N2me	S3m-N2e	S3nb-N2me	S3kw-N2me	S2kw-N2me	S2mn-N2ne	S2w-N2me	S1-N2me	S3w-N2ne	N2ms	S1-N2e	N2z-	S2kw-N2me	S3a*-N2me	S1>N2e	Conservation, smallholder farming on footslopes
			Siliceous plain with low karst (SLK)	4	None	Granodoro + Chacalte > Cuxu	3-5	Nutrients, moisture, root room, erosion	1	N2bm>S3mq	S3m-N2m	N2mn>N1mr	S3m-N2me	N1c>N2me	S2mn-N2e	S3nb-N2ne	N1mq-N2me	S3mq-N2me	S2mn-N2ne	S3mn-N2me	S3q-N2me	S3n-N2ne	N2ms	N2mn>S3m	N2z-	S3q-N2me	S3a*-N2me	S2n>N2e	Conservation
			Rolling plain (R)	4	None	Xpicilha + Cuxu	4	Shallow soils	3	S3mq-N2mk	S2m-N2m	N2mr>N1mr	S3mn-N1m	S3n-N1c	S2mn-N1m	S3n-N2m	N2k>N1n	S3mq-N2mk	S2m-N1m	S3mn-N2m	S2mk-S3mq	S3n-N1mn	N2s	S3m-N2m	N2z-	S3kq-N2mk	S3ma*-N2m	S1	Timber, conservation
			Rolling plain with low karst (RLK)	4	None	Chacalte > Cuxu	4-5	Shallow soils, variability, erosion	3 > 1	S2kw-N2me	N2m>S2w	N2me>N1mr	S3m-N2me	N1c>N2me	S2mn-N2e	S3nb-N2me	N1m-N2me	S3mq-N2me	S2mn-N2ne	S3mn-N2me	S1-N2me	S3n-N2ne	N2s	S1-N2e	N2z-	S3kq-N2me	S3qa*-N2me	S1>N2e	Timber, conservation
			Alluvial wash (W)	2	None	Machiquila + Chacalte	3	Nutrients, wetness, shallow soils	3 > 1	S3mw-N2mw	N1m-N2nw	N2nw>N1w	S3m-N2nw	S3n-N1w	S3m-N1wn	S3n-N2nw	N1m-N2mw	S3mn-N2nw	S2m-N2wn	S3mn-N2nw	S2wn-S3wn	S3wn-N1n	S2m-N2m	S1	N2z-	S3q-N2wn	S3ma*-N1wn	S1-S2n	Timber, conservation
			Siliceous undulating plain (SU)	1	None	Granodoro + Chacalte	3	Nutrients, moisture, root room	3 > 1	S2kw-N2bm	S2w-N2mn	N1w-N2mn	S3mw-N2mn	N1cn	S3nr-N1nr	S3bn-N2bn	S3kw-N2bm	N2bm>S3mq	S2mn-N2mn	S2w-N2mn	S1-S3mn	S3nr-N1n	N2ms	S1-N2mn	N2z-	S2kw-N1bm	S3a*m-N2mn	S1-S2n	Timber, pasture
			Gently sloping footslope (P)	1	None	Dancing Pool > (Curassow + Pippen)?	2	Nutrients	1	S3nb-N1bm	S2n>S3n	S2w>S3r	S1-S3mn	S2n>S3mn	S1-S2mn	N1n	S3n-N1n	S3nb-N1bm	S3n-N2n	S2n-N1mn	S1-S2mn	S1-S3r	N2s	S3m-N2m	N2z-	S3nb	S3na*>N1bn	S1n-S2n	Pasture, timber, conservation
			Valley bottom (VB)	0.4	None	San Lucas?	2	(Wetness, workability)	1	S2kw	S2w-N1w	N1w-N2w	S3w-N1w	N1cw	N1wn	S3nb-N1wn	S3kw	S2bk	S2n-S3n	S2w-S3w	S1-S2w	S3w-N1n	S2m-S3m	S1	N2z-	S2kw	N1a*	S1	Conservation
			Siliceous rolling plain (SR)	0.4	None	Chacalte > Granodoro	4	Nutrients, moisture, root room	3	N2bm>S3mq	S2w-N2mn	N1w-N2mr	S3mw-N2m	N1cn	S3nr-N1nr	S3nb-N2bn	S3kw-N2bm	S3mq>N2bm	S2mn-N2mn	S2w-N2mn	S1-S3mn	S3nr-N1n	N2ms	S1-N2m	N2z-	S2kw-N1bm	S3a*m>N2mn	S1>S2n	Timber, pasture
			Medium karst with siliceous plain (SMK)	0.2	None	Chacalte > (Cuxu + Granodoro)	3-5	Erosion, shallow soils, nutrients, moisture	1 > 3	S2kw-N2e	S2w-N2e	N2me>N1w	N2e>S3m	S3n-N2e	S3nr-N2e	S3bn-N2e	S3kw-N2e	N2e>S3m	S2mn-N2e	S2w-N2e	N2e>S1	S3nr-N2e	N2ms	N2e>S1	N2z-	S2kw-N2e	S3a*m-N2e	N2e>S1	Conservation
			Steep slope (S)	0.02	None	Cabro	5	Erosion, shallow soils	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z-	N2e	N2e	N2e	Conservation
CX	Vaca Hills	431	High karst (HK)	50	None	Shallow Cuxu	5	Erosion, shallow soils	1	N2mk	N2me	N2mr	N2e	N2e	N2e	N2me	N2mk	N2mk	N2e	N2me	N2e	N2e	N2s	N2e	N2z-	N2mk	N2me	N2e	Conservation
			Medium karst (MK)	20	None	Shallow Cuxu	5 > 4	Erosion, shallow soils	1	N2mk	N2me	N2mr	N2e>N1mr	N2e>S3mk	N2e>N1mb	N2me	N2mk	N2mk	N2e>N1m	N2me	N2e>S3mk	N2e>N1mn	N2s	N2re	N2z-	N2mk	N2me	N2e>N1e	Conservation
			Rolling plain with low karst (RLK)	13	None	Shallow Cuxu	4-5	Shallow soils, erosion	3 > 1	N2mk	N2m	N2mr	N1mr-N2e	S3mk>N2e	N1mb-N2e	N2m	N2mk	N2mk	S3m-N2e	N2m	S3mk>N2e	N1mn-N2e	N2s	N2re	N2z-	N2mk	N2m	S3e-N2e	Conservation
			Undulating plain (U)	5	Limited cultivation	Cuxu	3	Drainage, shallow soils	1	N1nk	S3m-N1m	N1mr	S3mn-N1mn	S3n	S2mn-S3mn	N1k	N1n	N1k	S2mn-N1mn	S3mn-N1mn	S2mk	S2n-N1n	N1mk-N2km	N1m-N2m	N2z-	S3k	S3ma*-N1w	S1	Conservation
			Valley bottom (VB)	4	Limited cultivation	Cuxu	3	Moisture, workability, nutrients	3	N1nk	S3m-N1m	N1mr	S3mn-N1mn	S3n	S2mn-S3mn	N1bk	N1n	N1bk	S2mn-N1mn	S3mn-N1mn	S2mk	S2n-N1n	N1mk-N2mk	N1m-N2m	N2z-	S3bk	S3ma*-N1mb	S1	Conservation
			Undulating plateau (π)	3	None	Shallow Cuxu	4	Shallow soils	3	N2mk	N2m	N2mr	N1mr	S3mk	N1m	N2m	N2mk	N2mk	S3m-N2e	N2m	S3mk	N1mn	N2m	N2r	N2z-	N2mk	N2m	S1	Conservation
			Low karst (LK)	3	None	Cuxu	3-5	Moisture, workability, erosion, nutrients	3 > 1	N2mk	S3m-N2me	N1mr-N2me	N1mr-N2e	S3mk-N2e	S2mn-N2e	N1bk-N2me	N1n-N2e	N1bk-N2e	S2mn-N2e	S3mn-N2e	S2mk-N2e	S3n-N2e	N2ms>N1mk	N1m-N2e	N2z-	S3bk>N2mk	S3ma*-N2e	S1>N2e	Conservation
			Siliceous undulating plain (SU)	1	None	Granodoro + Cuxu	3	Nutrients, moisture, root room	3 > 1	S3k-N1m	S3m-N2mn	N1mr-N2nr	S3mn-N2mn	N1cn	S2mn-N1nr	N1k-N2n	N1mn-N2m	N1k-N2m	S2mn-N2mn	S3mn-N2mn	S2m-S3mn	S3n-N1n	N1mk-N2m	S1-N2mn	N2z-	S3k-N1m	S3ma*-N2mn	S1-S2n	Timber, pasture
			Undulating plain with low karst (ULK)	1	Very limited cultivation	Cuxu	3-5	Shallow soils variability, erosion	1	N1nk>N2mk	S3m-N2me	N1mr>N2me	S3mn-N2e	S3n-N2e	S2mn-N2e	N1k>N2me	N1n>N2e	N1ke-N2e	S2mn-N2e	S3mn-N2e	S2mk-N2e	S2n-N2e	N1mk>N2ms	N1m>N2e	N2z-	S3k>N2mk	S3ma*-N2e	S1>N2e	Conservation
SS	Stopper Plain with Hills	10	Rolling plain (R)	68	None	Stopper? > Palmasito	3	Erosion (nutrients)	1	S3e	S3ne	S3e	S3ne	S3e	S2ne-S3ne	N1mn-N2mn	S3ne-N1ne	S2n-N1ne	N1e>N2n	S3ne-N1mn	S2n	S3e	N2s	N2m	N2z-	S2n-N1ne	S3ne-N1mn	S1	Conservation
			Undulating plain (U)	32	None	Stopper? > Palmasito	2	(Nutrients)	2	S2n	S2n	S2e	S3a*	S2e	S2n	N1mn-N2mn	S3n	S2n	S2ne-N2n	S3n-N1mn	S2n	S1-S2n	N1ms	N1m	N2z-	S2n	S3na*	S1	Conservation
VF	Chiquibul Terraces	9	Dissected terrace (dT)	77	None	San Lucas + Xpicilha + Canquin	2-3	Access, fragmentation, drainage, variability	1	S2kn>S3mq	S2wn-N1mw	S3wr-N2mw	S3a*>N1mw	S2c-N1w	S1-N1mw	S3b-N1wn	S3kn>N1mq	S1-S3mn	S2n-N1m	S2wn-N1mn	S1	S2nr-N1n	N1mb-N2ms	S1-N2m	N2z-	S2kn>S3q	S3a*	S1	Conservation
			Alluvial wash (W)	15	None	Quamina + San Lucas + Xpicilha	1-3	Drainage	1	S1-S3mq	S1-N1wn	S3w-N2mw	S3a*>N1mw	S2c-N1w	S3mw>N1mw	S2bn-N1wn	S3w>N1mq	S1-S3mq	S1*-N1m	S2w-N1mn	S1-S3q	S3w>N1n	S2m-N1s	S1-N2m	N2z-	S2kw>S3q	S3a*	S1	Conservation
			Floodplain (F)	9	None	Quamina?	1	(Flooding)	1	S1-S2f	S1-S3wf	S3wf	S3a*	S2c	S3w	S2bn-S3bn	S3w	S1-S2f	S1*	S2f	S1	S3f	S2f	S1	N2z-	S2f	S3a*	S1	Conservation

Land system[1]		Area (km²)	Main subunits[2]	Percentage area within land system	Current land use	Main soil types	Agricultural Value	Main limiting factors[3]	Conservation Value	Land suitability: Beans	Cacao	Cashew	Citrus	Coconuts	Coffee (Robusta)	Cotton	Groundnuts	Maize (mechanised)	Milpa (shifting cultivation)	Papaya	Pasture	Pineapple	Rice (mechanised)	Root crops	Shrimps	Sorghum	Sugar-cane	Timber	Provisional recommendations
MAYA MOUNTAINS																													
TR	Richardson Peak Mountains	971	Metasedimentary hills (o)	92	None	Cabbage Haul > Curassow	5	Erosion, root room	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Metavolcanic hills (v)	5	None	Richardson	5	Erosion	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Granitic hills (s)	3	None	Powder Hill + Mayflower	5	Erosion, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Metasedimentary scree (os)	0.2	Very limited milpa	Mayflower > (Cabbage Haul + Powder Hill	5	Erosion, shallow soils nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
VL	Chapayal Plateau	60	Rolling plain (R)	76	None	Granodoro > Chacalte	4	Nutrients, moisture, root room	3	S3mq> N2bm	S2w– N2mn	N1w– N2mr	S3m– N2m	N1cn	S3nr– N1nr	S3nb– N2bn	S3kw– N2bm	S3mq– N2bm	S2mn– N2mn	S2w– N2mn	S1– S3mk	S3nr– N1n	N2ms	S1– N2m	N2z–	S2kw– N1bm	S3a*m– N2mn	S1> S2n	Timber, pasture
			Undulating plain (U)	24	None	Granodoro > Chacalte	4	Nutrients, moisture, root room	3	S3mq> N2bm	S2w– N2mn	N1w– N2nr	S3m– N2m	N1cn	S3nr– N1nr	S3nb– N2bn	S3kw– N2bm	S2kw– N2bm	S2mn– N2mn	S2w– N2mn	S1– N1m	S3nr– N1n	N2ms	S1– N2m	N2z–	S2kw– N1bm	S3a*m– N2mn	S1> S2n	Timber, pasture
MP	Mountain Pine Plateau	320	Granitic plateau (pπ)	45	Pine logging	Pinol	4	Moisture, nutrients, erosion	1	N2mn	N2cn	N2n	N2mn	N2cn	N2mn	N2mn	N2n	N2mn	N2mn	N2mn	S3ne	N1mn	N2mn	N2mn	N2z–	N2mn	N2mn	Pine:S2n– S3e	Pine
			Metasedimentary plateau (cπ)	24	Pine logging	Cooma	4	Moisture, nutrients	1	S3mn– N1mn	N2cn	N2cn	S3mn– N2m	N2cn	S2mn– S3mn	N2mn	S3mn	N1mn	N2mn	N1mn– N2mr	S2mn– S3mn	N1mn	N2mn	N2mn	N2z–	N1mn	N2mn	Pine: S2n	Pine
			Metasedimentary valleys (cV)	9	Pine loggng	Cooma + Chiquibul	4–5	Moisture, nutrients, erosion	1	S3me– N2e	N2cn	N2cn	S3me– N2me	N2cn	S3e– N2e	N2mn	S3me– N2e	N1mn– N2e	N2mn	N1mn– N2me	S2mn– N2e	N1mn– N2e	N2mn	N2mn	N2z–	N1mn– N2e	N2mn	Pine:S2n– N2e	Conservation
			Granitic valley (pV)	9	Pine logging	Pinol	4–5	Moisture, nutrients, erosion	1	N2mn	N2cn	N2n	N2mn	N2cn	N2mn	N2mn	N2n	N2mn	N2mn	N2mn	N2mn	S3me	N2mn	N2mn	N2z–	N2mn	N2mn	Pine:S2n– N2e	Conservation
			High valleys (bV)	6	Firing range	Baldy	4–5	Moisture, nutrients	1	N2mn	N2cn	N2cn	N2mn	N2cn	N1mn	N2mn	N2mn	N2mn	N2mn	N2mn	S3mn– N2mn	N1mn	N2mn	N2mn	N2z–	N2mn	N2mn	Pine: S3nr	Conservation
			High plateau (bπ)	5	Firing range	Baldy	4	Moisture, nutrients	1	N2mn	N2cn	N2cn	N2mn	N2cn	N1mn	N2mn	N2mn	N2mn	N2mn	N2mn	S3mn– N2mn	N1mn	N2mn	N2mn	N2z–	N2mn	N2mn	Pine: S3nr	Conservation
			Quartz ridge (S)	1	None	Cooma	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
MF	Maya Mountains Floodplains	43	Dissected terrace (dT)	68	Very limited milpa	Canquin?	2	Access, fragmentation	3 > 1	S3a> S2n	S3a> S2n	S3ca	N1e> S2n	N2c> S1	S3a> S2r	S3ra	S3na	S3na	S2n– S3n	N1a> S3r	S3a> S1	S3a> S2d	N1mb	N1m	N2z–	S3a> S2n	N1a> S3a*	S1– S2a	Conservation
			Floodplain (F)	32	None	Monkey River > Canquin	1	Access, fragmentation, (flooding)	3 > 1	S2m– S3n	S1– S3wf	S3wf	S3a*	S1> S2r	S3w	S3bn	S3w	S1– S3n	S1*– S2n	S2f> S3r	S1	S3f	S2fm> S3m	S1	N2z–	S2f	S3a*	S1	Conservation
CR	Copetilla Mountains	214	Metasedimentary hills (c)	76	None	Cooma + Chiquibul	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Bare hills (b)	23	None	Baldy	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Granitic hills (p)	1	None	Pinol	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Metasedimentary scree (cp)	0.1	None	Pinol > Cooma	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
SO	Ossory Plain with Hills	34	Rolling plain (R)	56	None	Pippen > Curassow?	4	Nutrients, erosion	2	N1m	S3na	S3ra	S3ma	S3mn	S3a	N1mn	S3mn	N1m	N2n> N1n	S3mn– N1mn	S2mn	S3ra	N2s	N2m	N2z–	S3na	N1n	S2n	Conservation
			Undulating plain (U)	22	Very limited pasture, citrus	Pippen > Curassow?	4	Nutrients	3	N1m	S3a> S2mn	S3ra	S3ma> S2mn	S3mn	S3a> S2mn	N1mn	S3mn	N1m	N2n> N1n	S3mn– N1mn	S2mn	S3ra> S2r	N2m	N2m	N2z–	S3na	N1n	S2n	Conservation, pasture
			Gently sloping footslope (P)	12	None	Pippen + Dancing Pool + Curassow?	2	Nutrients	2	N1m> S3n	S2n> S3n	S3r> S2w	S1– S3mn	S3mn> S2n	S2mn> S1	N1mn	S3mn	N1bm> S3nb	S2n– N2n	S2n– N1mn	S2mn> S1	S1– S3r	N2m> S3m	S3m– N2m	N2z–	S3nb	N1n> S3nb	S1– S2n	Timber, pasture, citrus
			Gently sloping calcareous footslope (xP)	10	Widespread mixed farming, citrus	Chacalte/(Ossory > Stopper)	3	Variability, nutrients	4	S2k– N1m	S2w– N1m	S3r– N2mr	S3m– N1m	S3mn	S2mn– N1m	N1n> S3n	S3km– N1q	S2k– N1m	S2mn– N2n	S3mn– N1mn	S1– S3q	S2r– N1n	S3m– N2m	S1– N2m	N2z–	S2k– S3nq	S3a*m> N1n	S1> S2n	Pasture
TL	Palmasito Plateau	13	Rolling plateau (R)	82	None	Chiquibul?	4	Root room	1	N2r	N2r	N2r	N2r	N2cr	N2r	N2r	N2r	N2r	N2r	N2r	N1e	N2r	N2nr	N2mr	N2z–	N2r	N2r	S3q	Conservation
			Undulating plateau (U)	11	None	Chiquibul?	4	Root room	1	N2r	N2r	N2r	N2r	N2cr	N2r	N2r	N2r	N2r	N2r	N2r	S3r	N2r	N2nr	N2mr	N2z–	N2r	N2r	S3q	Conservation
			Hillslopes (H)	7	None	Chiquibul?	5	Root room, erosion	1	N2re	N2re	N2re	N2re	N2cr	N2re	N2re	N2re	N2re	N2re	N2re	N2e	N2re	N2nr	N2mr	N2z–	N2re	N2re	N2e	Conservation

	Land system[1]	Area (km²)	Main subunits[2]	Percentage area within land system	Current land use	Main soil types	Agricultural Value	Main limiting factors[3]	Conservation Value	Land suitability																			Provisional recommendations
										Beans	Cacao	Cashew	Citrus	Coconuts	Coffee (Robusta)	Cotton	Groundnuts	Maize (mechanised)	Milpa (shifting cultivation)	Papaya	Pasture	Pineapple	Rice (mechanised)	Root crops	Shrimps	Sorghum	Sugar-cane	Timber	
MAYA MOUNTAINS																													
TR	Richardson Peak Mountains	971	Metasedimentary hills (o)	92	None	Cabbage Haul > Curassow	5	Erosion, root room	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Metavolcanic hills (v)	5	None	Richardson	5	Erosion	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Granitic hills (s)	3	None	Powder Hill + Mayflower	5	Erosion, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Metasedimentary scree (os)	0.2	Very limited milpa	Mayflower > (Cabbage Haul + Powder Hill	5	Erosion, shallow soils nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
VL	Chapayal Plateau	60	Rolling plain (R)	76	None	Granodoro > Chacalte	4	Nutrients, moisture, root room	3	S3mq> N2bm	S2w– N2mn	N1w– N2mr	S3m– N2m	N1cn	S3nr– N1nr	S3nb– N2bn	S3kw– N2bm	S3mq– N2bm	S2mn– N2mn	S2w– N2mn	S1– S3mk	S3nr– N1n	N2ms	S1– N2m	N2z–	S2kw– N1bm	S3a*m– N2mn	S1> S2n	Timber, pasture
			Undulating plain (U)	24	None	Granodoro > Chacalte	4	Nutrients, moisture, root room	3	S3mq> N2bm	S2w– N2mn	N1w– N2nr	S3m– N2m	N1cn	S3nr– N1nr	S3nb– N2bn	S3kw– N2bm	S2kw– N2bm	S2mn– N2mn	S2w– N2mn	S1– N1m	S3nr– N1n	N2ms	S1– N2m	N2z–	S2kw– N1bm	S3a*m– N2mn	S1> S2n	Timber, pasture
MP	Mountain Pine Plateau	320	Granitic plateau (pπ)	45	Pine logging	Pinol	4	Moisture, nutrients, erosion	1	N2mn	N2cn	N2n	N2mn	N2cn	N2mn	N2mn	N2n	N2mn	N2mn	N2mn	S3ne	N1mn	N2mn	N2mn	N2z–	N2mn	N2mn	Pine:S2n– S3e	Pine
			Metasedimentary plateau (cπ)	24	Pine logging	Cooma	4	Moisture, nutrients	1	S3mn– N1mn	N2cn	N2cn	S3mn– N2m	N2cn	S2mn– S3mn	N2mn	S3mn	N1mn	N2mn	N1mn– N2mr	S2mn– S3mn	N1mn	N2mn	N2mn	N2z–	N1mn	N2mn	Pine: S2n	Pine
			Metasedimentary valleys (cV)	9	Pine loggng	Cooma + Chiquibul	4–5	Moisture, nutrients, erosion	1	S3me– N2e	N2cn	N2cn	S3me– N2me	N2cn	S3e– N2e	N2mn	S3me– N2e	N1mn– N2e	N2mn	N1mn– N2me	S2mn– N2e	N1mn– N2e	N2mn	N2mn	N2z–	N1mn– N2e	N2mn	Pine:S2n– N2e	Conservation
			Granitic valley (pV)	9	Pine logging	Pinol	4–5	Moisture, nutrients, erosion	1	N2mn	N2cn	N2n	N2mn	N2cn	N2mn	N2mn	N2n	N2mn	N2mn	N2mn	N2mn	S3me	N2mn	N2mn	N2z–	N2mn	N2mn	Pine:S2n– N2e	Conservation
			High valleys (bV)	6	Firing range	Baldy	4–5	Moisture, nutrients	1	N2mn	N2cn	N2cn	N2mn	N2cn	N1mn	N2mn	N2mn	N2mn	N2mn	N2mn	S3mn– N2mn	N1mn	N2mn	N2mn	N2z–	N2mn	N2mn	Pine: S3nr	Conservation
			High plateau (bπ)	5	Firing range	Baldy	4	Moisture, nutrients	1	N2mn	N2cn	N2cn	N2mn	N2cn	N1mn	N2mn	N2mn	N2mn	N2mn	N2mn	S3mn– N2mn	N1mn	N2mn	N2mn	N2z–	N2mn	N2mn	Pine: S3nr	Conservation
			Quartz ridge (S)	1	None	Cooma	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
MF	Maya Mountains Floodplains	43	Dissected terrace (dT)	68	Very limited milpa	Canquin?	2	Access, fragmentation	3 > 1	S3a> S2n	S3a> S2n	S3ca	N1e> S2n	N2c> S1	S3a> S2r	S3ra	S3na	S3na	S2n– S3n	N1a> S3r	S3a> S1	S3a> S2d	N1mb	N1m	N2z–	S3a> S2n	N1a> S3a*	S1– S2a	Conservation
			Floodplain (F)	32	None	Monkey River > Canquin	1	Access, fragmentation, (flooding)	3 > 1	S2m– S3n	S1– S3wf	S3wf	S3a*	S1> S2r	S3w	S3bn	S3w	S1– S3n	S1*– S2n	S2f> S3r	S1	S3f	S2fm> S3m	S1	N2z–	S2f	S3a*	S1	Conservation
CR	Copetilla Mountains	214	Metasedimentary hills (c)	76	None	Cooma + Chiquibul	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Bare hills (b)	23	None	Baldy	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Granitic hills (p)	1	None	Pinol	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
			Metasedimentary scree (cp)	0.1	None	Pinol > Cooma	5	Erosion, moisture, nutrients	1	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2e	N2s	N2e	N2z–	N2e	N2e	N2e	Conservation
SO	Ossory Plain with Hills	34	Rolling plain (R)	56	None	Pippen > Curassow?	4	Nutrients, erosion	2	N1m	S3na	S3ra	S3ma	S3mn	S3a	N1mn	S3mn	N1m	N2n> N1n	S3mn– N1mn	S2mn	S3ra	N2s	N2m	N2z–	S3na	N1n	S2n	Conservation
			Undulating plain (U)	22	Very limited pasture, citrus	Pippen > Curassow?	4	Nutrients	3	N1m	S3a> S2mn	S3ra	S3ma> S2mn	S3mn	S3a> S2mn	N1mn	S3mn	N1m	N2n> N1n	S3mn– N1mn	S2mn	S3ra> S2r	N2m	N2m	N2z–	S3na	N1n	S2n	Conservation, pasture
			Gently sloping footslope (P)	12	None	Pippen + Dancing Pool + Curassow?	2	Nutrients	2	N1m> S3n	S2n> S3n	S3r> S2w	S1– S3mn	S3mn> S2n	S2mn> S1	N1mn	S3mn	N1bm> S3nb	S2n– N2n	S2n– N1mn	S2mn> S1	S1– S3r	N2m> S3m	S3m– N2m	N2z–	S3nb	N1n> S3nb	S1– S2n	Timber, pasture, citrus
			Gently sloping calcareous footslope (xP)	10	Widespread mixed farming, citrus	Chacalte/(Ossory > Stopper)	3	Variability, nutrients	4	S2k– N1m	S2w– N1m	S3r– N2mr	S3m– N1m	S3mn	S2mn– N1m	N1n> S3n	S3km– N1q	S2k– N1m	S2mn– N2n	S3mn– N1mn	S1– S3q	S2r– N1n	S3m– N2m	S1– N2m	N2z–	S2k– S3nq	S3a*m> N1n	S1> S2n	Pasture
TL	Palmasito Plateau	13	Rolling plateau (R)	82	None	Chiquibul?	4	Root room	1	N2r	N2r	N2r	N2r	N2cr	N2r	N2r	N2r	N2r	N2r	N2r	N1e	N2r	N2nr	N2mr	N2z–	N2r	N2r	S3q	Conservation
			Undulating plateau (U)	11	None	Chiquibul?	4	Root room	1	N2r	N2r	N2r	N2r	N2cr	N2r	N2r	N2r	N2r	N2r	N2r	S3r	N2r	N2nr	N2mr	N2z–	N2r	N2r	S3q	Conservation
			Hillslopes (H)	7	None	Chiquibul?	5	Root room, erosion	1	N2re	N2re	N2re	N2re	N2cr	N2re	N2re	N2re	N2re	N2re	N2re	N2e	N2re	N2nr	N2mr	N2z–	N2re	N2re	N2e	Conservation

[illegible] Land system outliers also occur in other land regions

[illegible] A complete table of all subunits is given in Appendix 1 of the text.

[illegible] Brackets indicate only moderate to marginal limitations

BV = Belize Valley soil types (Jenkin et al., 1976)
SC = Stann Creek soil types (King et al., 1989)

AGRICULTURAL VALUES

1 = Major proportion of the area has high to very high income potential
2 = Chances for financial success good
3 = Chances for financial success moderate with the probability subject to skilled management
4 = Chances for financial success marginal even with skilled management and high inputs
5 = Chances for financial success extremely small

CONSERVATION VALUES

1 = High priority for conservation
2 = Moderate priority for conservation
3 = Marginal conservation value
4 = Very low conservation value

LAND SUITABILITY VALUES

S1 = Highly suitable
S2 = Moderately suitable
S3 = Marginally suitable
N1 = Currently not suitable
N2 = Permanently not suitable
* = Suitability for dry season crop (matahambre)

LAND SUITABILITY LIMITATIONS

a = access
a' = access to sea
a" = access to processing factory
b = size of manageable unit
c = cold temperatures
d = soil degradation hazard
e = erosion hazard
f = flood hazard
k = soil workability
m = moisture availability
n = nutrient availability
p = pollution
q = mechanisation potential
r = rooting conditions
s = slope
w = wetness
z = excess of salts
z– = insufficient salinity

APPENDIX 2: SOILS OF THE PROJECT AREA

Introduction

The main report contains a general description of the soils of the project area, (see Soils section), and Table 7-15 and the table accompanying Map 1 indicate the main soil types in each land system.

This appendix reports on the soil survey activities of the project, and amplifies the findings. Brief details on soil characteristics and distribution are summarized in Table A2.1. The text descriptions give more details and discuss the genesis and potential of each soil. It is assumed that the descriptions will be used for reference rather than narrative. Each description has been made fairly independent, without much cross referencing, which inevitably leads to some repetition. The descriptions and analyses of representative profiles of most of the soils are given in Appendix 3. The agricultural potentials are summarized in Table A2.3.

Field Methods

Methods of laboratory analysis are summarized in Appendix 2. In the field, the main method of soil examination was with a 1.2 m Edelmann auger. Over 1200 auger examinations were made at more than 1100 sites. Sites were located, on a free-survey basis, following examination of aerial photographs and satellite imagery. They were mostly in areas accessible by Landrover, but some were reached by boat, helicopter (courtesy of British Forces, Belize), and on foot. The locations are shown on Map 1.

Soil profiles were examined in detail and sampled for laboratory analysis at 89 sites. They are indicated with a circled spot prefix on Map 1; and with an 'OZ' prefix in the text, to distinguish them from profiles from previous Belizean surveys. These were mostly purpose-dug profile pits. Where road cuttings were used, they were cut back to a depth of at least 30 cm to ensure that undisturbed soil was examined and sampled. 187 samples from 64 profiles and one augering were analysed at the NRI Tropical Soils Analysis Unit. 76 samples from 24 profiles were sent to Central Farm to await analysis. One profile (OZ 87) was not sampled at all. Nine undisturbed Kubiena tin samples were collected from the main horizons of 5 profiles, and sent to Dr. E. A. FitzPatrick of the University of Aberdeen for micromorphological analysis and description.

A further seven profiles were seen in the area around Gallon Jug. They are part of the data collection for the Tropical Rainforest Ecology Experiment, jointly mounted and sponsored by the American National Geographic Society and the Jet Propulsion Laboratory of the National Aeronautics and Space Administration. The morphological, chemical and mineralogical data from these profiles will be available when the analyses are complete by Dr. P. Schoenberger of North Carolina State University.

The pits of the Texas Agricultural and Mechanical University's archaeology and soils investigation at Cobweb Swamp were also examined, but more briefly, by courtesy of Drs. C. T. Hallmark and J. Jacobs, as were the soils of Christian Reformed World Relief plots at Ranchito and San Victor, courtesy of Mr. T. Post and Dr. C. L. Coultas.

Previous Soil Surveys

The main soil studies of interest in the project area are those of Charter (1941), Wright *et al.* (1959) and Birchall and Jenkin (1979). Charter's was a reconnaissance survey of the whole of Belize north of the Maya Mountains, and therefore covering an area similar to our survey area. Despite its antiquity, brevity and absence of analytical data, his soils are clearly and accurately described, and generally easy to relate to those of later surveys and the present project.

The most important survey is that of Wright *et al.*, 1959. It is a substantial reconnaissance survey of the soils, natural vegetation and agricultural potential of the whole country. The present series of studies aims to amplify, modify and update it.

The soil survey of the Belize River Valley (Jenkin *et al.* 1976; Birchall and Jenkin, 1979), was at semi-detailed level, with published maps at 1:50,000 scale. It is therefore more intensive than the present study. Although not part of our project area, we have extended Map 1 with its accompanying land suitability to include the Belize Valley.

There are a number of other soil studies that concern only small parts of the project area. They are discussed in the descriptions of the relevant soils.

The Soils

FACTORS IN SOIL FORMATION

The project area encompasses a wide range of climates, lithologies and landforms; and the soils have evolved under a variety of pedogenetic environments. Nevertheless, generalizations are possible and useful when considering the project area's soils in regional, continental or global contexts.

The subtropical climate, with monthly mean temperatures generally in excess of 20°C, allows biological, physio-chemical and mineralogical processes in soils to proceed fairly continuously. Despite the well-marked 2-5–month dry season when little or no rain falls, the soils are at least moist for most of the year, so that the overall rate of weathering processes and biological activity tends to be high. The soils are subject to moderate or strong leaching for most of the year, site drainage permitting.

There are substantial areas of siliceous parent materials in the Maya Mountains and on the coastal plain, but the bulk of the parent materials are calcareous, so that most of the soils are of neutral or alkaline reaction, have high exchangeable base saturations, and are dominated by 2:1 swelling lattice aluminosilicate clay minerals. Such soils from calcareous parent materials contrast strongly with the acid, base-deficient, aluminium-dominated and 1:1 non-swelling lattice aluminosilicate clay mineral soils derived from siliceous parent materials.

SOIL CLASSIFICATION

The classification of the soils of the project area is summarized in Table A1.1. As in the Toledo and Stann Creek surveys (King *et al.*, 1986 and 1989), it is based on the three-tier hierarchical system of suite-subsuite-series used earlier in Belize (e.g. Charter, 1941; Wright *et al.*, 1959; Birchall and Jenkin 1979). As in Stann Creek, only the suites and subsuites are defined here. Elaboration to soil series level requires more detailed surveys (e.g. Birchall and Jenkin, 1979). As far as possible the suites and subsuites of Wright *et al.* (1959) have been retained. Where new names are necessary, they have been allocated at suite level, keeping the familiar names for the subsuites. A few names and definitions have been borrowed from the Belize Valley survey (Birchall and Jenkin, 1979). The suites are defined mainly in terms of parent materials, although some soil characteristics, e.g. colour and mineralogy are also used. The exception is Tintal Suite which includes all the soils that are either seasonally or permanently inundated, formed from a range of mostly transported parent materials.

The calcareous clays are separated into different suites according to the probable age and mineral impurities of the parent limestones. The actual pedogenetic significance of limestones of different geological age is uncertain, and it does not account for all the variation found, but it is a useful way of separating limestone soils occurring in different climatic regions and landscapes. It acts as a surrogate for a range of pedogenetic factors. At this stage it seems better to separate the suites to where differences in soils and their eco-agricultural performance are observed; and allow future pedologists to group them on the basis of detailed mineralogical and other data if appropriate.

The subsuites are differentiated on field characteristics that are apparently important for soil formation and agricultural utilization. Where chemical criteria are used in the definition, as in the Buttonwood Subsuite of the Puletan Suite, the property is associated with the occurrence of a very distinctive vegetation, and is easily recognized in the field.

The division into subsuites is not wholly consistent between suites. For instance, the subsuites of the calcareous clays over Cretaceous limestones in the Chacalte Suite are defined in terms of depth, with considerable internal variation in colour permitted; whereas the subsuites of the calcareous clays over northern facies equivalent of the Cretaceous limestones and Late Cenozoic limestones in the Yaxa and Pembroke suites are defined on colour, with large permissible variations in depth. Some of these inconsistencies are intentional and seem appropriate to the different types of soils. For example, the distinction between the black and red clays over limestone in the north has always been considered pedologically and agriculturally significant (e.g. Charter 1941, Wright *et al.*, 1959, Romney 1962). In contrast, the important feature of the predominantly dark calcareous clays in the south of the country is soil depth (e.g. Wright *et al.*, 1959). Other inconsistencies are historical, and reflect the piecemeal way in which the surveys were undertaken and the classification built up. Some unintentional and undesirable anomalies need to be resolved in the near future, before the system becomes too firmly entrenched.

In the brief descriptions of the soils in Table A1.1 and the following text, the main agricultural limitations are mentioned. 'Droughty' is used to indicate the soil's inability to retain an adequate reserve of available moisture, and does not refer to the climate. Soil 'droughtiness' arises from shallowness of the rooting zone, coarse textures, or a combination of both. If a soil is normally found on steep slopes, rapid runoff will also contribute to droughtiness.

SOIL CORRELATION

The correlations of the subsuites with earlier Belizean and the two main international systems of soil classification are summarized in Table A2.2. As the current system is based on that of Wright *et al.* (1959), correlation with that classification is fairly straightforward. Many of the soil descriptions of Charter (1941) are easily recognizable in terms of our system. At subsuite level correlation with the Belize Valley survey (Birchall and Jenkin, 1979) is also fairly simple, although some of their subsuites have been moved (e.g. Chucum has been moved from the Yaxa Suite to Tintal). Their Yobo Subsuite in the Puletan Suite has been largely incorporated into the Tok Subsuite of the Revenge Suite. Unless stated otherwise the suites and subsuites have the same meanings and definitions as used in the Stann Creek survey (King *et al.*, 1989)

Correlation with the international systems, especially the Soil Taxonomy (USDA, 1975; SMSS, 1990) is problematic. Their emphasis on argilluviation and exchangeable base status means that many of our taxa straddle high-level boundaries, even at order levels. For instance, soils of the Crooked Tree Subsuite of the Puletan Suite can fall into three different soil orders in the USDA Soil Taxonomy, and there are only 11 orders for all the soils in the world. In general, the Legend of the Soil Map of the World (FAO/UNESCO, 1974 and 1988) is more accommodating, although again our taxa can transgress some high level boundaries. Even when placement is not a problem, the grouping of some soils by the international systems is not satisfactory. Apparently similar soils can become widely separated.

SOIL SUITABILITY ASSESSMENT

All of the subsuites are assessed for their suitability for the main cropping systems under consideration. These assessments form the basis of the crop suitability assessments of the land systems and subunits in the table accompanying Map 1. In that table and in the previous studies in this series (King *et al.*, 1986, 1989) the soil subsuite assessments use the FAO notation (FAO, 1976).

S1	Highly suitable
S2	Moderately suitable
S3	Marginally unsuitable
N1	Unsuitable in current conditions but improvable
N2	Permanently unsuitable

For all classes except S1, the reasons for a soil's downrating are indicated by the following subscripts:

b	fragmentation of soil areas
c	low temperatures
d	degradation hazard – mostly by capping
e	erosion hazard
k	poor workability – usually high stone content
m	droughtiness
n	nutrient deficiency or imbalance
r	shallow rooting zone
w	excessive water
z	salinity

In the case of multiple limitations only the two most important are indicated. Some of the constraints relate to the location and distribution of the soils i.e. b and c, rather than their intrinsic morphological, physical or chemical profile characteristics.

The rationale of the assessments are briefly discussed in the following descriptions of each soils subsuite.

Soil Suites and Subsuites

The descriptions cover the following aspects of each soil subsuite:

(i) Location and importance;

(ii) Natural vegetation;

(iii) Profile morphology;

(iv) Analytical characteristics;

(v) Possible genesis;

(vi) Classification in the current system used in this study;

(vii) Correlation with soils in previous Belizean studies, and with the international soil classification systems;

(viii) Distinction from other subsuites;

(ix) Possible criteria for subdividing into soil series;

(x) Present use;

(xi) Limitations and potential for future use, and recommendations.

The descriptions and discussions are abbreviated in the cases of soils of very limited extent or which were little seen in the course of fieldwork, usually because of inaccessibility.

Turneffe Suite

The Turneffe Suite contains the weakly developed soils formed in marine deposits along modern and old shorelines. They are all of limited extent and little agricultural importance. Their current and potential economic importance is mainly as venues for tourist and recreational developments. Four subsuites are distinguished:

Shipstern – shallow calcareous sediments over solid coral; Ambergris – deep raw calcareous soils; Hopkins – deep, raw siliceous sands, along the modern coast; Matamore – slightly more developed soils on the siliceous sands of relict strand plains.

Shipstern Subsuite

The soils of the Shipstern Subsuite occur quite extensively, in places close to the coast in the northern part of the country. They occupy coral flats just above the high water mark. The natural vegetation is mangrove savanna, wherein low stunted black and red mangrove and buttonwood trees occur in grass and sedge savanna. In places, bare coral outcrops occupy a considerable proportion of the ground surface.

The soils consist of shallow calcareous deposits resting on coral. They are heterogeneous in colour and texture, due to the range of sediments in these general low energy environments. Many of the soils consist of thin layers of brown or grey, often peaty, silty clay or clay, overlying hard coral. There is virtually no horizonation in the shallower profiles, where the coral may be encountered within 10 cm of the surface. In deeper deposits there is a distinction between the topsoil and subsoil in the degree of organic darkening (e.g. Profile OZ 31 in Appendix 3). Although most are fine-textured, there are also some shallow calcareous sands over hard coral.

The soils are moderately alkaline. Their salinity depends mainly on their topographic position relative to inundation levels. Inundated soils are usually saline throughout, but slightly elevated soils are partly leached. In profile OZ 31, which is partly leached, the EC of the subsoil is less than 4 mmhos/cm. Exchangeable sodium and magnesium levels are high, but calcium is the most important exchangeable cation.

The soils are very young, so that topsoil organic enrichment and some leaching of soluble salts are the only processes that have so far taken place. The underlying coral has hardly begun to weather and is still hard. It provides the main contribution of soluble calcium.

Charter's (1941) classification has no equivalent of the Shipstern Subsuite. Darcel (1952c) describes, but does not map or name, soils of this type. In Wright *et al.* (1959), the Shipstern coarse sandy loams and clays (sets 1b and 1c) appear to be similar to these soils.

In the international systems, youth and shallowness take precedence over variable salinity as the diagnostic criteria. The soils are therefore Lithic or Eutric Leptosols (FAO/UNESCO) and probably Lithic Troporthents (USDA).

The soils are shallower, usually less than 30 cm, and often finer, than the calcareous sands of the Ambergris Subsuite. The saline gleys of the Ycacos Subsuite in the Tintal Suite are deeper, wetter and more saline.

It is difficult to foresee any need for detailed survey and subdivision of these soils into series. If necessary the best criteria for series definition are depth, texture and salinity.

The soils are virtually unused at present: just occasional small plots of coconuts and pineapples on pockets of deeper soils. They have very severe physical limitations for agricultural crops. Their very shallow depths and the impenetrable hardness of the underlying coral make them very droughty. There are also severe chemical limitations in the saline soils, so that the overall agricultural potential is low, as can be seen in Table A2.3.

Ambergris Subsuite

Ambergris Subsuite soils occur where comminuted coral sand has accummulated to some depth and sufficiently rapidly to preclude much pedogenetic development. The soils cover the strand plain along or close to the modern coast. Their natural vegetation is beach forest with teabox, seagrape and cocoplum trees. The vegetation is prone to recurrent natural disturbance by hurricanes. Many of these forests have also been removed by development of residential tourist and recreational facilities.

The soil profile is very simple with little pedogenetic horizonation. The topsoil may show some organic darkening, but in many profiles even the surface horizons are white, with very low organic matter contents. The texture is sandy, mainly calcareous, but there may also be some gravel and stones. The subsoil is also white, sandy and calcareous. There is little soil aggregation and structures are mostly single grain. Consistence is normally loose, but there may be compaction in some lower horizons due to packing density. Some subsoils show slightly darker bands, which may be due to buried topsoils or to limited translocation of mobile organic matter. The dry or moist sandy subsoil is as deep as one metre on some beach ridges. In other sites it may be shallower and overlie hard coral at depths as little as 30-50 cm. On the lower slopes of swales and other depressions, the lower subsoil may be wet, with white-light grey matrix colours and faint yellowish mottling.

The soils are slightly alkaline. Calcium is the dominant exchangeable cation, but the total cation exchange capacity is very low because of the very low organic matter and clay contents. Most other nutrients are very deficient except for magnesium in some soils.

The simple profile morphology, lack of accumulation of organic matter, and topographic position indicate that these soils are still very undeveloped. Because of their predominantly calcareous parent material, leaching leads mainly to solution, and has not yet depressed the soil reaction or base saturation.

Charter (1941) does not include any soils of this type. Darcel (1952c) describes similar soils on Cay Corker and Cay Chapel. Wright *et al.* (1959) distinguish between calcareous and siliceous beach sands, and this soil corresponds with the Turneffe sand set (1c). The correlations with the international classifications are relatively clear, with Eutric Regosols in the FAO-UNESCO Legend and with Troporthent or Tropopsamment, depending on whether the sand is deeper than 125 cm, in the USDA Soil Taxonomy.

The soils might be confused with those of the Shipstern, Hopkins and Ycacos subsuites. The soils of the Shipstern Subsuite are shallower with hard coral occurring at a depth of 30 cm, and often less. Hopkins Subsuite soils are formed in siliceous sand. They are more acid and base-deficient than Ambergris soils, especially in the better-drained sites on the slightly older strand plains. The soils of the Ycacos Subsuite have more impeded drainage than even the wettest Ambergris soils, with permanent gley conditions at depths of less than about 70 cm.

The limited extent and low agricultural potential mean subdivision of the soils into series is unlikely to be necessary . Particle size, depth to coral and subsoil drainage are probably the most useful criteria, should subdivision be necessary.

Currently, the main agricultural use of these soils is for coconuts, which are mostly grown on a casual basis, supplementing some other economic activity: increasingly the service sector of the tourist industry. Tourism is also taking over many areas of these soils as sites for various facilities.

Agriculturally, these soils have very limited potential. Their extremely coarse textures makes them very droughty. Where there is groundwater at depth to offset the moisture stress, it is often saline or brackish. The soils are also very deficient in nutrients and will require heavy and well-balanced fertilization. As can be seen in Table A2.3, they are rated as unsuitable for most crops, and marginal for drought-tolerant crops with low nutrient requirements such as coconuts, cashew and pineapple. Cassava also has some limited potential, but the future value of these soils lie in their beach location and lack of mangroves, favouring tourist developments.

Hopkins Subsuite

Hopkins Subsuite soils form in modern and recent siliceous beach sands. They are presumed to occur in the Stann Creek Strand Plain land system and upper tidal flat of the Toledo Saline Swamps land system, because they were found in these locations in the Stann Creek area (King *et al.*, 1989). They are not thought to occur any further north because they require a source of siliceous beach sand. The Maya Mountains are the main source for these soils, and their sediments do not stretch far north from their draining rivers, because the predominant longshore drift is from north to south.

The natural vegetation is beach forest, which consists mainly of seagrape, with some pine, on the ridges; and palmettoes in the swales. There may be small ponds and swamps with open sedge vegetation in the wetter depressions. These forests are very vulnerable to hurricane damage.

Soil profiles have only a rudimentary development. The topsoil may be distinctly darkened with organic matter, and there is sometimes a thin needle litter layer under pines; but some of these soils are bare of litter and have white or light grey topsoil colours. The subsoils are very light coloured. They are deep on the ridges, but grade into wet and faintly mottled horizons in the swales. Textures are coarse throughout, with sands and loamy sands predominant and no horizons finer than sandy loam. There is little aggregation and structures are overwhelmingly single-grained. Soil consistence is usually dry and loose.

The whiteness of the sands tends to accentuate the apparent melanization of topsoils, and organic matter contents are moderate or low. The soils are thought to be leached and slightly acid, and have only moderate base saturation. Because of the low organic matter and clay contents, the cation exchange capacities are very low, as are the total exchangeable bases. Clay contents are also very low, with no sign of translocation downwards. The soils are young with very limited pedogenetic development. Some initial leaching of bases and organic melanization of the upper horizons are the only processes apparent in the well-drained soils. In the imperfectly drained soils of the swales some mottling has developed, which is unlikely to become more pronounced because of the relatively low iron content of the almost pure quartzose parent material.

There is no equivalent to these soils in Charter's (1941) classification. They correspond to Wright *et al.*'s (1959) Turneffe coarse sands (set 1a), which are defined in terms of their highly quartziferous parent material. In the international systems the better-drained profiles are Dystric Regosols (FAO/UNESCO) and Orthic Tropopsamments (USDA Soil Taxonomy), or Gleyic Regosols (FAO/UNESCO) and Aqueptic Tropopsamments (USDA) in the swales.

The swale soils grade towards Ycacos or Sibal subsuites, according to the salinity of the water, at the very poorly drained end of the scale. The soils of these latter subsuites are generally perennially saturated at depths of less than about 70 cm. The soils of the Matamore Subsuite are more leached, more intensely coloured, and occur on a distinct and older set of relict inland strand plains. The soils of the Ambergris Subsuite are calcareous and alkaline.

The extent and agricultural potential are so limited that there is little need for detailed surveys and subdivision into soil series. If necessary, drainage is likely to be the most useful definitive criterion.

Because of their very coarse textures the soils tend to be very droughty. The exceptions are some of the swale soils, but in many of these the poor drainage is a considerable constraint. The soils are also very deficient in all important plant nutrients. Because of their low organic matter and cation exchange capacities, they will require substantial, frequent and carefully managed fertilization. This combination of constraints is reflected in the low suitability ratings for most crops in Table A2.3. The more drought-tolerant crops such as cashew are considered moderately suitable, whereas coconuts, pineapple and cassava are considered only marginally suitable.

As with the Ambergris Subsuite, the development potential of these soils is not in agricultural development, but in tourism and recreation.

Matamore Subsuite

The soils of the Matamore Subsuite are formed on relict strand plains up to 5 km inland composed of mainly siliceous sand. They were not seen during the fieldwork for this survey, but small outliers of more extensive deposits south of the project area are inferred from the remote sensing imagery. They only occur in the south of the project area, where rivers drain out of the Maya Mountains – the main sources of siliceous material.

The original ridge and swale morphology has been eroded since they were left behind by marine regression, so that they now tend to form low whalebacks. The natural vegetation varies from low semi-deciduous broadleaf forest to pine ridge tree savanna. The forest has a high proportion of black and white maya, polewood, hogplum, wild coffee, mylady and pimento palm. Some of the savanna areas have fairly dense clumps of well-grown oaks but much of the natural vegetation has been removed. The soils tend to be farmed by the Garifuna populations of coastal villages.

The soils have a moderately darkened topsoil of sand – sandy loam texture, overlying a deep uniform pale brown or yellow sand – sandy loam. Structure is weak, often crumbling readily to single grain. The consistence is very friable even loose in places. There may be some reddish yellow mottles below a depth of one metre, sometimes accompanied by an increase in clay content, although never heavier than a sandy clay loam texture.

There is moderate leaching and a slightly acid reaction (pH in water 5-6). Base saturation percentages are also moderate (50-80%), but the low clay and organic matter contents mean that the cation exchange capacity is low, and consequently the quantities of total exchangeable bases are low. Other nutrients such as nitrogen and phosphate, both total and available, are also low.

The soils have formed from *in situ* leaching and weathering since the emplacement and abandonment of the strand plain. Their moderate reaction and exchangeable base status reflects their fairly short pedogenetic lives. The high intensity of leaching is probably due to the high permeability and free drainage. Their limited weathering and rubefaction is also partly due to the youth of these soils; but the preponderance of unweatherable quartz in the parent material gives low initial contents of iron, so that the potential for rubefaction is very limited in any case. The occurrence of slightly finer textured horizons at depth indicates some incipient translocation of clay.

The classification of these soils in the Belizean system is reasonably clear, on account of their distinct location and clear genetic relationships with the other strand soils in the Turneffe Suite. They also correlate well with the Matamore soils (sets 46 and 46a) of Wright *et al.* (1959). The soils correspond approximately with the Matamore Subsuite of King *et al.* (1989), except that those included some deep white sands with incipient humus podzolization, which are now placed in the Crooked Tree Subsuite of the Puletan Suite.

In the international systems, the soils can be classified into different taxa. If they remain coarse-textured (i.e. sandy loam or coarser) to a depth of more than one metre, they are Arenosols, either Luvic, Haplic or sometimes Ferralic, in the FAO/UNESCO system; and Tropopsamments in the USDA Soil Taxonomy. If textures of sandy clay loam are encountered within the top metre, they are Eutric or Dystric Regosols (FAO/UNESCO) and Troporthents (USDA).

The soils are distinct from those of other subsuites in the project area because of their topographic position and deep, uniform, coarse textures and weakly rubefied profiles. The soils of the Hopkins Subsuite are younger, coarse and paler. The soils of the Crooked Tree Subsuite are whiter, coarser, often have incipient humic podzolisation and invariably have an abrupt boundary to a brightly red and white mottled, compact and finer textured lower subsoil within the top 3 m, usually shallower.

These soils have already been widely used for agriculture in Stann Creek District (see King *et al.*, 1989). They may require detailed surveys in the future and warrant subdivision into series. Depth, subsoil texture and intensity of subsoil mottling are likely to be the most useful criteria.

The soils are very freely drained and tend to be droughty on account of their coarse textures, but the good drainage and relatively friable subsoils mean roots can ramify freely and exploit a considerable depth for moisture reserves. The predominance of quartz and moderately intense leaching lead to low chemical fertility, but the soils have proved suitable for a range of hardier crops, such as cashew, pineapples and coconuts. Their free drainage and friability also make them suitable for root crops, particularly cassava, but they are unsuitable for crops vulnerable to moisture stress and nutrient deficiencies. These considerations are indicated in the suitability ratings of Table A2.3.

MELINDA SUITE

The Melinda Suite includes all well- and imperfectly drained soils developed in riverine alluvium. They are mainly found in the valleys of the rivers draining out of the Maya Mountains, in the south of the project area. The mountains are the source of considerable volumes of siliceous alluvium. The calcareous outcrops that cover most of the north give rise to large areas of shallow and stable soils, and generate very little alluvium. Only one inextensive subsuite of this suite has been identified in the north.

The mainly siliceous alluvial soils in the valleys of the Belize and Sibun river systems, occur at variable heights above the river, and vary in age. The floodplain and low floodpain bench soils are still subject to regular inundation and further alluvial accretions. They are young soils and retain predominantly alluvial features. They may also have imperfectly drained subsoils due to the shallowness of the current water table. The soils of the older and higher floodplain bench and terrace deposits are only very infrequently or no longer inundated and have had time for alluvial characteristics to fade and pedogenic features to develop. These soils are generally well above water table influences, and are well-drained.

Five subsuites have been distinguished in the project area:

Monkey River	Young soils on mixed siliceous alluvium;
Quamina	Young soils on mixed siliceous and calcareous alluvium;
Pasmore	Young clays in calcareous alluvium;
Canquin	Older high floodplain bench and terrace soils on mixed siliceous alluvium;
Sennis	Young soils on mixed siliceous alluvium overlying brightly mottled and compact older alluvium.

It should be noted that the project area is restricted to the middle and upper parts of the valleys. A greater diversity of alluvial soils were identified in the lower reaches during the semi-detailed survey of the soils of the Belize Valley (Birchall and Jenkin, 1979) and the reconnaissance of the Stann Creek District (King *et al.*, 1989).

Monkey River Subsuite

The soils of the Monkey River Subsuite develop in wholly siliceous alluvium on floodplains and low floodplain benches where flooding still regularly occurs. During the survey the soils were found in the valleys of the upper reaches of the tributaries of the Sibun, especially Caves Branch and the Sibun itself. Further downstream calcareous influences become stronger and the geomorphologically equivalent soils belong to Quamina subsuite, indicated by a 'c' prefix to the subunit designation in the Cayo Floodplains land system. The alluvium that gives rise to the Monkey River soils is derived from a range of siliceous rock types, and contains high proportions of quartz and muscovite. These soils are mainly located on levées and the more freely draining parts of these deposits. The natural vegetation has been largely removed or greatly disturbed. Originally, it ranged from tall evergreen – semi-deciduous riparian forest to dense herbaceous bush known locally as vega. The forest has a varied composition, often with bribri as a prominent component. Vega bush grows rapidly after flooding to produce a generally soft foliage and fine woody tissues.

The soil profile is characterized by alluvial layering, which is very prominent in the lower and younger soils. Textures vary from boulders and cobbly sand to clay, with frequent silts and fine sands. Boulders and cobble beds are more frequent in the upper parts of the valleys, particularly in the Maya Mountains Floodplains land system. A similar distribution was noted in North Stann Creek, where the alluvial soils at Middlesex are more rudaceous than downstream (King *et al.*, 1989). Textural boundaries are abrupt to clear, according to the vagaries of deposition. The topsoil is brown, occasionally dark brown, but melanization is not pronounced. In the subsoils, brown, yellow and grey colours predominate but reddish horizons are also found. Layers rich in glinting silvery muscovite flakes are found in some soils. Grey and brown mottling occurs in the subsoils of the intermittently poorly drained profiles. Structures are rather weakly developed: crumb in the topsoil and blocky in the subsoil. There are rarely any clayskins on subsoil ped faces. Consistences are generally moderately friable. There is a tendency for surface capping when silty or very fine sandy textured topsoils are exposed to direct raindrop impact.

The soils are moderately leached and slightly acid, but constant renewal with fresh alluvium produces a reasonably high chemical fertility. Total contents of nutrient, especially muscovite-derived potassium, are mostly moderate-high. The soils are generally permeable and freely drained down to the water table, which can rise temporarily to the surface during floods, and may always be within the top two metres of some soils close to river level.

The morphological and chemical features indicate the young age of the soils. Intensive leaching is completely negated by the repeated deposition of new parent material.

Because of the high agricultural potential of the soils, there have been a number of soil studies and surveys in various parts of the country. They correspond to the Stevenson, Pelly and possibly Melinda and Fresco suites, of Charter (1941), although the relative ages and development status of these suites is not very clear. They are more or less equivalent to the Monkey River Subsuite of Wright *et al.*, (1959). Some of them would qualify for the Quamina Subsuite in the classification of the Belize Valley survey (Birchall and Jenkin, 1979).

There have also been detailed surveys of limited areas that have referred to these soils by various local names. The Alta Vista soils of North Stann Creek appear to be equivalent (Darcel, 1952d). Associations IV and V (Hershey, Savannah Bank, and Caves Branch series, and Alluvial Land) on the Hershey Estate on the Sibun River correspond approximately to the Monkey River Subsuite, although some of them may be sufficiently high, old and well-developed to qualify for the Canquin Subsuite (Wagner *et al.*, 1987).

In contrast, the correlation of these soils with the international classification is reasonably clear. In the FAO/UNESCO Legend the well-drained soils are Eutric or Dystric Fluvisols, according to exchangeable base status, whereas the wetter profiles probably qualify as Eutric or Dystric Gleysols. Similar considerations of base status make the better drained soils Eutric or Dystric Tropofluvents, and the wetter soils Eutric or Dystric Fluvaquents in the USDA Soil Taxonomy.

The main identification problems with these soils are their demarcation from Quamina, Canquin and Sibal subsuites. Quamina can occupy topographically similar sites, and are of similar morphological appearance except that Quamina tends to have slightly darker topsoils. The distinction is made on the basis of a calcareous contribution to the parent material, even if only in flooding by hard water, indicated by the soil pH and base status, especially exchangeable Ca.

The soils of the Canquin Subsuite are older and more developed. In appearance they have redder colours, less alluvial layering, and more pedogenetic horizonation. They are also characterized by a tendency to compact subsoil consistences, in contrast to the relatively friable subsoils of the Monkey River Subsuite.

The wetter soils of the Monkey River Subsuite grade into the unequivocal gleys of the Sibal Subsuite. The distinction is so far not rigidly defined, but a permanent water table and intense gleying at a depth of about 70 cm is taken as a working boundary.

As noted above, some areas of these soils have already been surveyed in detail. A variety of soil series have been proposed and named. Charter (1941) used the origin and mineralogy of the alluvium as the main criteria. On the Hershey Estate, Wagner *et al.*, (1987) defined series on the basis of drainage and degree of development. The series definitions in this subsuite need to be clarified and codified in any future revision of the classification of Belizean soils.

At present, large areas of these soils are intensively used, mainly for citrus plantations in the Sibun River and St Margaret's Creek valleys. There is also some cacao and citrus in the Caves Branch Valley, as well as extensive cattle pastures.

The free drainage of most, and high chemical fertility of all, of these soils means that they have agricultural potential and flexibility. The main constraints are periodic flooding, the suspect drainage of some of them, and the tendency to cap and erode. The current emphasis on permanent tree crops should be maintained, and arable cultivation should be avoided. When under tree crops, particularly in the open canopy stages, care is needed to establish and maintain ground cover. Although annual crops are damaged by periodic flooding, once well-established, tree crops are able to withstand the uprooting pressures of the moving flood waters, and do not appear to be harmed by brief periods of high water tables and surface water, as long as these are moving and oxygenated.

Another hazard derived from the topographic position rather than the soil properties, is the occurrence of cold spells. During cold weather, cold air can spill down the steep Maya Mountains slopes and collect in the valley bottoms. The problem is most severe in the very lowest parts of the valleys adjacent to the higher mountains, such as the upper reaches of the Sibun and Caves Branch, and in the Maya Mountains Floodplains land system.

Quamina Subsuite

The Quamina Subsuite contains young soils developed in mixed siliceous and calcareous alluvial parent materials. They are found in limestone basins where siliceous alluvium has been imported and overlies limestone. They also occur where siliceous alluvium is periodically permeated with hard, calcareous flood waters. In the project area they occur on the low floodplain benches of the valleys of the middle and lower reaches of the rivers draining northwards out of the siliceous Maya Mountains (i.e. in the Cayo Floodplains land system) and through the flanking Cretaceous limestones (i.e. in the Hummingbird Plain with Hills land system).

The natural vegetation is similar to that of the Monkey River Subsuite, ranging from fairly tall evergreen to semi-deciduous broadleaf forest to dense, soft-tissued herbaceous 'vega' bush.

The soil profile morphologies cover a similar range to those of the Monkey River soils. Textures are layered, with high proportions of silt and fine sand; but because they occur further downstream, these soils tend to have less rudaceous components, and boulder and cobble beds are rare. Some of the soils have bands of silvery muscovite flakes. The topsoil is usually dark brown – brown, often slightly darker than the surface horizon of Monkey River soils. Subsoil colours are variable, with greys and browns predominating. Soils in the lower positions may be mottled and even gleyed at depth. Structures are weakly developed, crumb in the topsoil and subangular blocky in the subsoil. There are few if any clayskins on the subsoil ped faces. Consistence is generally friable in the topsoil and no more than slightly firm in the subsoil. As in the Monkey River Subsuite, there is a tendency for surface capping in silty or very fine sandy topsoils.

The soils have a neutral or slightly alkaline reaction. Base saturation is total or at least very high, with calcium as the dominant exchangeable cation. Total nutrient contents are moderate-high, especially for potassium in soils with muscovite.

As in the Monkey River Subsuite, the persistence of the alluvial layering, the lack of marked pedogenetic horizonation, and the incomplete weathering and slight rubefaction of the minerals indicate that these soils are very young, with periodic renewal by fresh alluvium negating the weathering and acidification tendency of the leaching.

Charter (1941) mentions a calcareous phase of the Wood Series in which siliceous alluvium overlies limestone, and which is therefore probably equivalent to the Quamina Subsuite. He also describes a Kate's Lagoon Suite as alluvial and acid over limestone, but this is more likely to be related to the Revenge Subsuite of this study than to the Quamina, especially as its natural vegetation appears to be Pine Ridge. The soils of the Quamina Subsuite in this suite appear to correspond with the Quamina Subsuite of Wright *et al.* (1959). The better drained young alluvial soils in the Belize Valley are all classified in the Quamina Subsuite, but some of them are quite leached, slightly acid and appear to show little calcareous influence. They therefore correspond more closely to the Monkey River Subsuite than to the Quamina Subsuite as defined in this study.

The main problem in identification of these soils is at the boundary with those of the Monkey River Subsuite. The Quamina soils are more alkaline, have higher base saturations and especially higher exchangeable calcium. The topsoils tend to be rather darker, but otherwise the two subsuites share similar morphological ranges, and occupy similar topographic positions.

As with the Monkey River Subsuite, the soils of the Quamina Subsuite also grade into the redder, older and more horizonated soils of the Canquin Subsuite, and into the gleys of the Sibal Subsuite.

As with Monkey River Subsuite, the soils of the Quamina Subsuite have high agricultural potential and are likely to warrant detailed surveys. The most useful criteria for the necessary subdivision into series are likely to be drainage and degree of pedogenetic development. There is less likely to be any need for discrimination on the basis of mineralogy and lithological provenance of the siliceous components. In the project area these soils are mostly either already under citrus or are currently being cleared for citrus expansion. There are still some areas that are under high bush or wamil, but these are also likely to be cleared once road access is improved.

The free drainage and high nutrient fertility suggests high agricultural potential and flexibility. Even the coarser-textured soils do not tend to droughtiness because of the shallow groundwater and lateral inflow from upslope. Silty and fine sandy topsoils tend to cap if exposed to direct impact by rainfall. The soils are therefore best suited to perennial tree crops. Cacao should do well as long as the rainfall is sufficient, but these soils tend to occur downstream and in slightly drier areas than those of the Monkey River Subsuite. Citrus is already successful. Tree crops generally need good ground cover, especially before canopy closure.

The flooding hazard for annual crops is the same as for the Monkey River Subsuite, and is not considered serious for tree crops. The orographic flow of damagingly cold air is likely to be less than on the Monkey River soils. Most of the Quamina soils are further downstream and therefore further from the high mountain sources of the cold air masses. Despite these minor contraints, the soils are potentially valuable and flexible agricultural soils, as is shown by their ratings in Table A2.3.

Pasmore Subsuite

The soils of the Passmore Subsuite are formed in fine-grained alluvium derived from limestone soils in the northern part of the project area. They are inextensive and patchy because the interfluve limestone soils are generally permeable, shallow and stable, so that the very limited surface runoff causes little erosion. Some material is washed downslope, but few of the streams and rivers deposit much alluvium. The rivers certainly lack the clearly differentiated floodplain bench and terrace systems that are formed in the much more voluminous siliceous alluvium in streams issuing out of the Maya Mountains.

The natural vegetation is fairly tall semi-deciduous broadleaf forest, often with many pucte and red gombolimbo trees.

The soil profile consists mainly of fairly deep black and dark grey clays. There is some tendency to colour banding, with alternating dark and less dark layers. As the soils are almost entirely heavy clays, there is no massive textual layering, but occasional thin bands of rounded limestone gravel are found. The soils are imperfectly drained, and some subsoil brown and yellow mottling occurs. The subsoils may also contain substantial quantities of well-crystallized gypsum. Because of the limited volume of alluvium from these catchments, these soils are only moderately deep and usually overlie limestone at depths of less than two metres – sometimes much less. Structures are fine blocky in the topsoil, becoming coarser and more pronounced with depth. Wedge structures and slickensides have been seen in some subsoils.

The soils are moderately alkaline and completely base-saturated, with calcium as the dominant exchangeable cation. Total and available phosphate levels are probably moderate. The organic carbon and total nitrogen levels are also thought to be moderate, and not as high as the dark colours suggest. The texture is very fine and clay contents probably exceed 70% in most horizons.

The soils are young and show some textural stratification in the form of limestone gravels, but the source catchment produces such fine grained sediment that the fine earth fraction is relatively homogeneous. The alluvial origin is more apparent in the muted colour bonding. There does not appear to have been any argilluviation between horizons, but there appears to be some short-range redistribution of clay in the form of pressure faces and slickensides in the lower subsoil.

There are no clear equivalents of these soils in Charter's (1941) classification. Their closest analogues in Wright *et al.* (1959) are the alluvial calcareous clays of the Hondo Subsuite, but Pasmore Subsuite soils do not appear to occur along the major rivers, such as the Hondo or New River, but rather on intermediate and small streams such as Pasmore Creek, after which the subsuite is named. Some calcareous alluvial clays were identified and mapped in the semi-detailed survey of the Belize Valley (Birchall and Jenkin, 1979). The nearest equivalent to Pasmore Subsuite are their Iguana and Cox series.

In the international systems the soils are Eutric or Mollic Fluvisols where well-drained, possibly with some Eutric Gleysols in imperfectly drained sites, in the FAO/UNESCO Legend. The equivalents in the USDA Soil Taxonomy are Eutric Tropofluvent and Eutric Fluvaquent.

The soils are distinguished from the deeper hillwash variants (subunit 'W') of the interfluve calcareous deep clays in Louisville, Yalbac and Ramgoat subsuites by the colour banding, the layering of limestone gravel and their topographic situation along the banks of streams. They differ from some of the darker clays in the Pucte and Chucum subsuites in that they are better drained, less gleyed, and their vegetation is broadleaf forest rather than akalche bush.

The soils occur in such small pockets that they are not likely to warrant subdivision into series.

At present, these soils are unused, but small patches of them are likely to have been used in ancient Maya raised/channelled field systems. The forest on these soils contains a few sapote and other secondary timber species, which have been logged at the same time as the surrounding areas, especially between Hill Bank and Gallon Jug, such as at Pasmore Creek.

These soils have considerable capacity for available moisture. They also have moderate – high nutrient contents. Their agricultural potential is constrained by flood hazard and intermittently high water tables, which is reflected in their suitability assessments in Table A2.3.

Canquin Subsuite

Canquin Subsuite soils are formed in old siliceous alluvium. They are the main soils of the high floodplain benches and terraces in the valleys of the major streams draining out of the Maya Mountains. In the project area, they are found in the valleys of the Sibun and Caves Branch, with smaller areas along St Margaret's Creek, the Macal River, and probably in Barton Creek. The terraces are slightly dissected so that the flat to very gentle alluvial slopes are interrupted by short, sharp convexities. The natural vegetation is tall, semi-deciduous broadleaf forest, but it has mostly been removed and the soils are mostly intensively cultivated for citrus and, formerly, cacao, and used for pasture. The remaining forested areas are being rapidly cleared.

The soil profile is characterized by considerable depth, bright reddish colours and subsoil compaction. The topsoil is moderately darkened with organic matter. It has a moderate crumb or fine blocky structure and friable consistence. It grades into the deep red or yellowish red subsoil, which has a moderate medium or coarse blocky structure. The consistence of the subsoil is variable but tends to become extemely firm and even compact below about 70 cm depth. The compaction does not appear to preclude penetration by tree roots. The lower subsoil may also become weakly mottled, with yellow and brown patches, but the mottling and compaction are not invariably associated. Some bright reddish subsoils can be very difficult to dig or auger.

The textures are mostly medium – fine. They are relatively homogeneous, but some of the old alluvial layering may persist in the form of concentrated beds of boulders, cobbles and sand. These rudaceous layers are more common in the upper parts of the valleys. There are also bands of muscovite flakes in some profiles. There are some signs of clay translocation in the finer-textured subsoils and some clayskins on subsoil ped faces. Silt and fine sand are plentiful, and may lead to surface capping if the topsoils are exposed to the direct impact of rainfall.

The soils are leached and acid, with pHs commonly below 6 and base saturations below 50%. The total content of nutrients is variable, tending to be low for calcium and magnesium, but quite high for potassium in horizons containing muscovite.

The blurring of textural layering, the acidity and low exchangeable base status indicate that these soils have been subject to subaerial weathering and leaching for a considerable time. They are now so high above base level that they are not replenished by fresh alluvium, except for rare catastrophic floods inundating the high floodplain benches.

The soils correspond to the Stevenson Suite and some of the Pelly Suite soils of Charter (1941). They are almost the exact equivalents of the Canquin Set of Wright *et al.* (1959). The soils of the Redbank Subsuite in the Belize River Valley (Birchall and Jenkin, 1979) are from similar parent material and in similar topographic positions, but appear to include a higher proportion of poorly drained soils. Only the Listowel Series is freely drained and red enough to be considered similar to Canquin. Soils similar to the Canquin Subsuite were surveyed and characterized as Melinda and St Thomas series in the detailed survey of the Heshey Estate (Wagner *et al.* 1987). Their acidity and low base status were noted, but there is no mention of subsoil compaction.

In the international systems, the weathering and leaching are deemed more important than the alluvial origins; so the soils are Dystric Cambisols in the FAO/UNESCO Legend and Fluventic Dystropepts in the USDA Taxonomy.

The soils are relatively easily distinguished from the younger alluvial soils of the Monkey River Subsuite by their redder colours, more intense leaching and acidity, less marked alluvial layering and the subsoil compaction. The rounded boulder and pebble beds, the layers of muscovite, and high silt and fine sand contents distinguish these soils from the sedentary and hillwash soils on adjacent hillslopes.

The soils have a moderate – high agricultural potential, and have already been considerably developed. Some areas have been surveyed in detail (e.g. Wagner *et al.*,1987), and more such surveys are likely in the future. Subdivision into series is therefore likely to be necessary and useful. Wagner *et al.* (1987) distinguished a relatively well-drained Melinda Series from the imperfectly drained St Thomas Series. Apart from the confusing and unfortunate name of the first series, this subdivision ignores variation in subsoil compaction and should therefore not be allowed to become too rigid a precedent. They also used topsoil texture and surface gradient as criteria for phase definitions.

Canquin soils have been intensively developed for citrus in Stann Creek District (King *et al.*, 1989). Within the project area they have been developed for citrus, cacao and pasture. Experience at their plantation has led Hummingbird Hershey Ltd to discontinue cacao on most of these soils. This crop is now concentrated on the less compact and acid soils of the low floodplain bench (Monkey River and Quamina subsuites). The higher floodplain bench and terrace soils of the Canquin Subsuite are being converted to citrus, but similar soils were used quite sucessfully for cacao at Sittee River in Stann Creek District in the 1950s. Recently cleared Canquin land in the vicinity of the Hershey plantation is also apparently being prepared for citrus. The pastures in the valley of the Caves Branch on these soils appear to be productive, but apparently are also being converted to tree crops, mainly citrus.

The soils provide crops with fairly good physical conditions. The depth and medium and fine textures mean available moisture capacities are potentially high. Drainage in most of these soils is good or only slightly impeded. The main physical constraint is the compaction of the subsoils, which may well have contributed to the indifferent performance of cacao on these soils at the Heshey plantation; but both the roots of the native forest trees and citrus appear able to penetrate the compact horizons. The chemical charateristics of these soils are more limiting for crop production. The acidity, deficiencies of cationic nutrients, and low levels of phosphate make these soils relatively infertile. The mediocre performance of cacao at the Heshey plantation was attributed mainly to this chemical infertility (Wagner *et al.*, 1987).

Nonetheless with sufficient and well-balanced liming and fertilizers, these soils can be very productive, especially for citrus. The need for costly chemical inputs makes them better suited to commercial plantations than to subsistence smallholders.

Sennis Subsuite

Sennis Subsuite soils are widely scattered but not extensive in the project area. They are formed where a moderately thick layer of fresh alluvium is deposited over old coastal alluvium. They occur where modern floodplains adjoin old coastal deposits, and where exceptional floods have splayed out. In the project area they occur mainly in the south, where the floodplain of the Sibun River abuts against the Pine Ridge coastal deposits in the Cornhouse Creek area. There are also areas in the north where much smaller streams have deposited dark calcareous clay alluvium over the old coastal deposits.

The natural vegetation on the siliceous alluvial soils is Broken Ridge or Broken Pine Ridge, often with a ground cover of cutting grass. The Sennis soils derived from calcareous alluvium have fewer pines and cutting grass; and common broadleaf species include pixoy, cockspur and black maya, with abundant botan palms.

The soils have complex and variable morphologies. The siliceous soils have an upper part of the profile similar to the Monkey River Subsuite overlying a brightly mottled 'corned beef' subsoil of the Puletan Suite. The upper layers are grey or brown, and have a textural layering with occasional bands of muscovite. The subsoil is compact sandy clay loam – sandy clay with bright white, yellow and red mottling.

The calcareous soils consist of the upper part of a soil of the Pasmore Subsuite overlying a Puletan subsoil. The upper layers consist of dark grey or greyish brown clays, sometimes faintly mottled with thin bands of limestone or quartzose gravel.

The chemical properties are also complex and variable. The siliceous soils tend to have a neutral reaction in the upper layers with moderate – high contents of available and total nutrients. The underlying subsoil is acid and very base-deficient. The contents of other nutrients are also low. A similar dichotomy between the upper layers and lower subsoil appears in the soils derived from calcareous alluvium: the upper horizons are slightly alkaline, and have high and calcium-saturated cation exchange capabilities. Total contents of other nutrients are also high – moderate. The brightly mottled subsoil is acid and deficient in nutrients. The genesis of these soils appears to be related to the difference in age between the two parts of the material. The acidity and low base status, highly segregated mottles and the compaction of the subsoil are due to prolonged and intense weathering, leaching and pedogenesis of a siliceous parent material. The subsoils are thought to have been originally the lower part of a Puletan-type Planosolic profile. At a later stage, the original sandy topsoil of the Puletan was swept away by changes in river levels and courses, and fresh alluvium deposited in its place. Pedogenesis in the fresh alluvium is limited by its youth, and the occasional replenishment with new material in high floods.

The more siliceous of these soils appear to correspond to some extent with the Baker Suite of Charter (1941), but the pedogenetic origin of that soil is not at all explicit. These soils appear to match some of the properties of the Sennis Set of Wright *et al.* (1959), but they attributed the alluvium to local sources in the Pine Ridge coastal deposits and not to long distance stream transport. Accordingly, their Sennis was classified as part of the Puletan Suite. The soils appear somewhat similar to the Willows Bank Series in the Belize Valley (Birchall and Jenkin, 1979).

The mixed origin of these soils makes it possible to classify them in a variety of ways in the international systems. If the fresh alluvium is the dominant feature, they can qualify as Eutric, Dystric or Gleyic Fluvisols in the FAO/UNESCO Legend and Eutric or Dystric Tropofluvent or Tropaquent in the USDA Taxonomy. If, however, the contrast between the upper young alluvium and the mottled subsoil is stressed, the soils may qualify as Eutric or Dystric Planosols (FAO/UNESCO) and Albaquults or Albaqualfs (USDA Soil Taxonomy).

Within the project area, the main identification problems concerning these soils are with the Monkey River, Pasmore and Haciapina subsuites. Where the fresh alluvium is more than about a metre deep, the importance of the mottled subsoil is diminished, and the soils are regarded as belonging to the Monkey River Subsuite if siliceous; or Pasmore, if calcareous. The Haciapina Subsuite also consists of a deep layer of transported soil over a mottled Puletan subsoil, but here the upper layers are locally derived and consist of pale sandy wash from

Puletan profiles upslope – not stream-borne, finer-grained and more fertile alluvium.

The soils occur as widespread small pockets and their total area is small. They do not justify detailed soil surveys, but may be included in surveys of other soils. There may therefore be a need for subdivision into soil series. With such a heterogeneous group, there are many possibilities for definitive criteria, such as texture and nature of the fresh alluvium, its depth and the drainage. However, the soil series so defined are likely to occur in spatially intricate patterns and may be unmappable.

Many of these soils remain uncleared and the mixed and low natural vegetation, and the presence of cutting grass renders them unattractive to milpa smallholders.

The agricultural potential is very variable, basically depending on the depth of the fresh alluvial layer of sandy loam. Where deep, or finer, these soils have sufficient similarities to the soils of the Monkey River or Pasmore subsuites to be moderately fertile and flexible. The underlying compact mottled layer tends to restrict deep penetration by roots, and produce physiologically somewhat shallow soils prone to droughtiness. The mottled layer also has a low permeability so that the drainage of the lower part of the fresh alluvium layer is rather impeded. Where the fresh alluvium is shallower, the mottled compact subsoil becomes a more important part of the root environment. Its compaction, low permeability, acidity and low nutrient status considerably limit its agricultural potential. This variability of potential is reflected in the considerable spread of suitability assessments in Table A2.3.

PULETAN SUITE

The soils of the Puletan Suite are found on the deeper deposits of siliceous old alluvium emplaced upon the coastal plains. The largest areas occur on the coastal plain east of the New River, but substantial areas are found further west, especially along the eastern shore of the Booth's River Lagoon and stretching northwards.

Where the siliceous deposits are shallow, and limestone occurs within range of biological recycling (up to about 2 m), the soils of the Revenge Suite are formed. Puletan soils form in deeper deposits, in which plants grow in a wholly siliceous environment.

The siliceous parent material is thought to be derived from the crystalline or metasedimentary rocks of the Maya Mountains. Clasts of these are found in some of the deposits to the south of the Belize River. Further north, the greater distances travelled from the source appear to have completely comminuted them, and the deposits are stone-free. The age of the deposits is unknown, but it seems likely that they date back at least as far as the mid-Pleistocene and possibly Tertiary (B. Holland, 1991, personal communication).

The soils of the Puletan Suite are mostly covered with the very distinctive lowland Pine Ridge vegetation. This is mainly tree savanna dominated by *Pinus caribaea*, often in association with oaks, crabboe, sandpaper and calabash trees. There are also occasional patches of open woodland, and grass and sedge savanna. The Pine Ridge has a distinctive appearance on aerial photographs and satellite images, but soils other than those of the Puletan Suite may carry similar vegetation.

Puletan soils display most of the characteristics of planosols with pale coloured upper horizons, generally very coarse-textured, which grade rapidly, even abruptly, into a lower subsoil that is prominently mottled red, yellow and white. The subsoil is much finer-textured than the overlying horizons and is often markedly compact and impermeable. The soils are moderately acid, and very leached and base-deficient. Phosphate and nitrogen levels are low. The marked increase in clay content, often over quite short depth intervals, appears to be mostly due to clay illuviation from the upper to the lower layers. The textural contrast encourages waterlogging of the upper layers in wet weather, and possibly clay mineral weathering by ferrolysis. The ionic weathering products can be removed vertically or laterally by overland flow or throughflow. The process of textural differentation may therefore be self-re-inforcing. The mottled subsoil is a considerable barrier to root penetration and water percolation, which means the vegetation has to subsist on the stored moisture resources of the coarse-textured upper horizons in dry spells, and can become severely moisture-stressed. During wet periods the upper horizons are more or less saturated and poorly aerated.

The soils of this suite therefore impose severe physical and chemical limitations on root systems, crop growth and agriculture, and support a natural vegetation of low biomass, diversity and productivity. Consequently, they have very limited agricultural potential.

Within the project area, six subsuites have been distiguished:

(i)	Crooked Tree	Very deep (>50 cm) dry sandy topsoils, often with an illuvial humic B horizon;
(ii)	Boom	Shallower (<50 cm) sandy topsoil;
(iii)	Bocotora	Fragments of plinthite and ferricrete in the mottled subsoil. Variable topsoil depths and textures;
(iv)	Backlanding	Medium-textured topsoils. Mostly fairly shallow;
(v)	Haciapina	Wet pale and deep sandy topsoils. In drainage lines or other accumulation sites;
(vi)	Buttonwood	Morphologically similar to Boom or Backlanding, although less compact in subsoil, but saline throughout.

Crooked Tree Subsuite

These soils mostly occur on the higher interfluves of the old coastal deposits. They are most extensive on the Pine Ridge that runs north-south to the east of New River from Carmelita to the project area boundary north of Lemonal. They are particularly common around the village of Crooked Tree. They are characteristic of the Crooked Tree Plain land system. The vegetation is a vigorous tree savanna, almost dense enough to form woodland in places. The dominant trees are large oaks and pines, but crabboes, palmettoes and wild cashews are also present. Because of the vigour of the tree components, the ground cover is sparser than in other Pine Ridge. Stretches of bare white sand beneath and between the trees are characteristic and aid remote sensing recognition.

The upper part of the profile consists of thin or absent grey topsoil over deep, strikingly white or sometimes light grey or very pale yellow sand. The sands are usually medium, occasionally coarse-grained. Structures are invariably single grain. By definition the sand is more than 50 cm deep, but it can stretch to well over a metre. It reaches 150 cm in Profile OZ 54, and 120 cm in Profile OZ 59. Depths of over 2 m have been seen in similar soils outside the project area, to the west of Burrell Boom (Birchall and Jenkin, 1979). Some of the sandy upper layers, especially where less than a metre deep, are fairly uniform beneath the slightly darkened top few cm; but in most of the deeper sands there are clear signs of podzolization. The upper profile then consists of a thin slightly darkened topsoil, a very white eluvial sand, and a brown sand of humus illuviation, which may be underlaid by a distinctly yellower or even strong brown sand, thought to be a very weak Bs horizon of iron illuviation. In many soils, however, there appears to be so little iron initially in the parent material that no Bs horizon is possible. Beneath the illuvial horizons, the pale sand continues with little variation down to the mottled horizon.

The mottled horizon is usually sandy clay loam or finer, representing a massive increase in clay content, usually over a short distance. The colours are distinctly variegated bright reds and whites, with mottles of yellow, dark brown and strong brown. The red patches may be slightly indurated or have occasional haematitic concretions, but no coarse fragments of plinthite or ferricrete are found. The horizon has a firm-compact consistence, and a massive or closely packed angular blocky structure. There are distinct clayskins, and substantial clay illuviation from the overlying sand seems to have occurred.

The soils are moderately acid and very leached throughout the profile. The pH in water is in the range 5-6, but contents of exchangeable bases are very low and base saturations are often less than 10%. Phosphorus content, both available and perchloric acid-extractable, is low.

The genesis of these soils is as problematic as in the rest of the suite. Clay eluviation from a parent material initially coarse textured, is considered the main process. Ferrolytic weathering may be less important in this subsuite, because the great depth of the sands means the upper layers at least are only briefly waterlogged.

Augering these soils to a depth of 1.2 m often reveals only white sand, but deeper examination shows the mottled and finer textured subsoil is invariably present, even if at considerable depth; hence their classification in the Puletan Suite.

However, the deep sand and the humic podzolization seem to justify separation at subsuite level, although the Belize Valley survey only separates the soils at series level (Santos Pine Ridge and Double Head Cabbage series) within the Boom Subsuite, which encompasses all of the sandy-topped non-calcareous soils in their Puletan Suite (Birchall and Jenkin, 1979).

In the international systems these soils can fall into a number of high level taxa. Where the sandy top is more than 125 cm thick and non-podzolized, the sandiness is the main criterion (Arenosol in FAO/UNESCO, Psamment in USDA). Where the sand is deep and podzolized, the soils may qualify as Carbic Podzols (FAO) or Tropohumods (USDA). Where the sand is less than 125 cm deep, the textural segregation becomes the main criterion, and the soils are probably Dystric Planosols (FAO) or some kind of Albaquult (USDA). This illustrates the problems of applying the international systems to a group of Belizean soils that are relatively coherent in terms of their properties, distribution, ecology, and potential.

The normal dry or moist state of the sandy upper horizons distinguish them from the deep and normally wet sandy top soils of the Haciapina Subsuite. The latter are also never podzolized, because of the lack of free drainage and intensive leaching. The tree savanna on Crooked Tree soils is also quite different from the wet grass and sedge savanna of the Haciapina soils. The deeper soils in the Bocotora Subsuite are similar to those of Crooked Tree in having deep sandy upper horizons, which are sometimes podzolized, and the characteristic tree savanna. However, they are distinguished by the definitive presence of coarse plinthite patches or ferricrete fragments in the subsoil. Crooked Tree soils are easily distinguished from the Boom Subsuite in having more than 50 cm of sand, and from the Backlanding Subsuite in having sandy or loamy sand, rather than medium textured, upper horizons.

Crooked Tree soils have the highest level of current use and future potential in the Puletan Suite. It may therefore be quite appropriate to undertake more detailed surveys in the future. The obvious criteria for defining series are the depth of the sandy top and the presence or absence of humic podzolization; but the grain size, angularity and coatings of the topsoil sands may be important if surveys are being conducted for non-agricultural purposes, such as the extraction of construction sand or using the sand as a raw material for glass.

The soils are still mainly under natural and semi-natural tree savanna, which is used as a source of pine and oak timber, and is also extensively grazed by cattle and horses, especially in a wide area around Crooked Tree village. Close to the village the soils are used for cashew. This tree is well suited to deep and dryish sands, and is producing fruit and nuts at levels beyond the labour capacity of the village to process them. There is considerable depredation by parakeets, who are spreading the seeds to produce wildings in unplanted and unharvested areas, such as the higher parts of the interfluve to the east of Revenge Lagoon.

As well as cashew and pasture, the soils have some potential for citrus, pineapples and cassava. Of these, citrus is likely to be the worst hit by the low available moisture capacity of the very coarse textures. It is also the crop that will need most nutrient supplementation with lime and fertilizers. Despite these limitations these are still the most productive and adaptable of the soils in the Puletan Suite.

Boom Subsuite

Boom Subsuite soils are probably the most extensive Puletan soils in the project area. They occur under a variety of Pine Ridge tree savanna vegetation, in which the trees are normally neither dense nor tall. There are also areas of open savanna with occasional clumps of palmetto in or surrounding wetter ground. The soils occupy whole interfluves in some Pine Ridge areas. They also occur on the lower parts of the interfluves that are capped with the deeper sands of the Crooked Tree Subsuite in the Lemonal-Carmelita Pine Ridge. They are commonly found in the August Pine Plain land system.

The morphology consists of dark grey or grey sand-loamy sand topsoil, which is weakly structured or single grain. The topsoil overlies a pale coloured sand or loamy sand subsoil invariably with a single grain structure. Light grey, pale yellow, yellow or pale brown variants are found, but the dazzling white colours of the Crooked Tree Subsuite do not generally occur. There is no trace of humic podzolization in this horizon. It is likely to be moister than the upper parts of the deep sand of the Crooked Tree Subsuite for much of year.

The lower subsoil is very similar to that of the Crooked Tree Subsuite, consisting of red and white brightly mottled sandy clay loam or sandy clay, also with brownish and yellowish patches. It is moderately to very compact, with a massive or tightly packed angular blocky structure. It appears to be only slightly permeable to water and is penetrated by only a few roots. Some of the red patches may be slightly indurated as haematitic grit, but there are no coarse fragments of plinthite or ferricrete. Borrowpits and quarries show this horizon extending to depths of 2-3 m and more.

The granulometric analyses emphasize the abrupt textural discontinuity in these profiles. For example, the clay content increases from 1-37% over a depth interval of 30 cm in Profile 0Z 14 (Appendix 3). The soils are moderately acid (pH 5-6 in water), but the exchangeable bases are very low, as are other nutrients, such as nitrogen and various forms of phosphate. Trace elements are also low.

As in the Crooked Tree Subsuite, clay translocation is considered to be an important process in the initial formation of these soils. Further textural segregation by ferrolytic weathering of clays in the topsoils may also be significant. Their relatively shallow depth to the impermeable subsoil means that the upper horizons become readily saturated by a perched water table in wet weather. They therefore experience the alternating wetting and drying necessary for ferrolysis more intensely and frequently than the deeper soils of the Crooked Tree Subsuite. The relative shallowness of the topsoil is attributed at least partly to profile truncation. When saturated, the coarse texture and poorly structured upper horizons have very low cohesion, and are easily moved by wash or creep processes. The creep material removed probably provides the parent material of the deep wet sands of the Haciapina soils in accumulation sites downslope.

Boom Subsuite soils correlate well with the shallower sets in the Puletan Suite of Wright *et al.* (1959), and with parts of the shallower series (the shallower soils in Double Head Cabbage Series, the coarser-textured soils in Hattieville Series, and the non-ferrugious gravelly soils in Colonel English Series) in the Boom

Subsuite of the Belize Valley survey (Birchall and Jenkin, 1979). They are morphologically very similar to the Savannah and Serpon subsuites of the Puletan Suite on the Southern Coastal Plain (King *et al.*, 1989) but, for the present, they are being kept as separate subsuites. Future studies, especially on the mineralogy of these various soils, may indicate that they should be amalgamated. The placement of these soils in the international systems is clearer than for the Crooked Tree Subsuite. The textural discontinuity and the low base status are the main criteria, so that they qualify as Dystric Planosols in the FAO/UNESCO system and as Haplaquults or Paleaquults in the USDA Soil Taxonomy.

They are easily distiguished from other subsuites in the Puletan suite. The sandy topsoil is shallower (and usually moister) than in Crooked Tree, shallower and drier than in Haciapina, and coarser textured than in Backlanding subsuites. Boom Subsuite lacks the coarse fragments of plinthite or ferricrete diagnostic of the Bocotora Subsuite. The soils most easily confused with the Boom Subsuite are the Revenge Suite, which also have planosolic profile forms, but they have limestone or calcareous horizons within rooting depth, whereas Boom soils are acid and base-deficient to depths of <2 m. As these soils are of low agricultural potential, detailed soil surveys and the definition of soil series are unlikely to be necessary, but similar soils are being developed in the Central Coastal Plain. If such developments occur in the north, soil series may need to be defined. Similar soils in the south were distinguished according to the degree of subsoil compaction, and assumed root penetrability. The depth and texture of the topsoil may also be useful criteria.

At present these soils are largely unused except for very extensive grazing and the extraction of a few pine logs, but various residential, cashew, citrus and pasture projects are currently (1990) in preparation.

Agriculturally, these soils impose a variety of severe limitations on crops. The compact and impermeable subsoils preclude much root penetration, so that crops have to subsist on the resources of the shallow sandy topsoils. In the wet season, these are frequently saturated and poorly aerated. In the dry season, their shallowness and coarse texture makes them very droughty. The nutrient status is very low all of the time. Because of this combination of severe constraints these soils are assessed as being of very low agricultural potential. Those with less compact and more rootable subsoils are probably marginal for cashew, coconuts, pasture and rice. Those with denser subsoils are thought to be moderately suitable for rice provided that they are heavily fertilized, but are rated as currently or permanently unsuitable for most of the other cropping systems considered.

Bocotora Subsuite

The Boctora Subsuite is not extensive within the project area. The soils occur along the Manatee Road in the southern part of Belize District. They occur mostly on the middle plain subunit of the Belize Plain land system. The soils carry a range of Pine Ridge vegetation from pine forest with large oaks and pines, to fairly open savanna with scattered clumps of palmetto.

The upper part of the profile encompasses the full range of Crooked Tree and Boom Subsuites. Beneath the thin organically darkened sandy topsoil, the pale coloured sands and loamy sands can vary in depth from 30->100 cm. In the deeper soils there may be traces of a brown illuvial humic horizon at a depth of around 25-50 cm, indicating weak podzolization. The distinctive feature of these soils is the occurrence of substantial fragments of plinthite and ferricrete in the mottled subsoil horizons. These horizons resemble other Puletan subsoils in having distinct coarse red and white mottles and sandy loam-sandy clay textures. They differ in that the red patches are often plinthitic, being soft-slightly hard in place in the profile, but indurating to form truly lithic ferricrete material when exposed to the atmosphere, as in road construction. The hardness of the *in situ* plinthite makes these subsoils very or extremely firm, and give a characteristic 'grinding' feel when they are augered or dug. The soils resemble other Puletan subsuites in being moderately acid but very base-deficient. They are low in all of the main plant nutrients. Their granulometric analyses confirm the field textures in showing a large and abrupt increase in clay content at the pale sand/mottled sandy clay junction.

It is difficult to account for the amount of iron and the reason for its plinthitic segregation. The subsoils are not visually redder or apparently more ferruginous than those of other subsuites. The difference is that the iron is more readily remobilized and aggregated. The main environmental difference that may account for this distinctive behaviour is the presence of nearby limestone hills, and the possible greater age of these soils, as indicated by the 'stepped' landscape. It is suggested in the Geology section that the middle plain subunit represents Dixon's (1956) 15 m level marine terrace. Proximity to limestone greatly facilitates the precipitation of manganese as hard black dioxide concretions, often mixed with ferruginous sesquioxides. In these Bocatora soils, the manganese is unimportant, but limestone may affect the precipitation of the iron, although this is usually attributed to redox changes rather than to pH and/or soluble calcium.

The classification of these soils in the Puletan Suite is clear. The main taxonomic query is whether the presence of plinthite in the subsoil should be a criterion for subsuite status. The soils could have been placed in the Crooked Tree or Boom subsuites, according to the depth of the sandy upper layers, and then separated as plinthitic series, variant or phases. Their present separation at subsuite level is influenced by their distinctive environmental setting.

The correlation of these soils with previous Belizean and international classifications is summarized in Table A2.2. The plinthite does not account for a high enough proportion of the mottled horizon, nor is it usually shallow enough to qualify these soils as plinthosols in the FAO/UNESCO system, nor as plinthaquults in the USDA Soil Taxonomy. The pisolitic Cornhouse Series of Charter (1941) is a limestone soil and quite dissimilar, despite being named after a major creek that runs through the Bocotora area.

These soils are easily distinguished from the other subsuites in the Puletan Suite by the subsoil plinthite and ferricrete, which is rare in other suites. The soils can be subdivided into series on the depth of the sandy topsoil. Other possible criteria include the degree of induration of the plinthite, although this is rather ephemeral and can be intensified by exposure.

The soils are hardly used, except for limited pine extraction and very extensive cattle grazing. Some of the subsoil material is being used for roads, but so far these soils have not been quarried to the same extent as those of the rather similar Borrowpit Subsuite in Stann Creek District (King *et al.*, 1989)

Because of the depth range of the sandy upper layers, the soil encompasses the combined range of agricultural potentials of both Boom and Crooked Tree subsuites. Some of the deeper sands have some potential for pasture and the nutritionally less demanding tree crops such as cashew. The shallow soils have low potential for almost all crops (see Table A2.3).

Backlanding Subsuite

Few of these soils were seen in the course of the survey, but they have been described and mapped in adjacent areas in the Belize Valley (Birchall and Jenkin, 1979), and are thought to cover considerable areas, usually interspersed with soils of the Boom Subsuite. Their natural vegetation is a rather patchy Pine Ridge with some low stature pine-crabboe savanna, in which oaks are relatively unimportant, and areas of open savanna with palmettoes. The distinct morphological feature of these soils is the medium, and occasionally fine, texture of the upper horizons. They have a similar colour profile to the soils of Boom and Bocotora subsuites, with their darkened topsoils, over yellow-pale brown-white upper subsoils, abruptly over red and white mottled compact lower subsoils. The boundary to the mottled horizon is generally quite shallow, usually less than

40 cm. Topsoil textures are mostly in the range sandy loam-sandy clay loam, but there are occasional clay loams. Although not as dramatic as in sandier subsuites, there is still a marked textural discontinuity from the pale to the mottled horizons, with clay contents often doubling or more, so that the lower horizon usually qualifies as a clay or sandy clay. The mottled horizon is compact and only slowly permeable. Like the rest of the suite, these soils are moderately acid but very base-deficient. Other nutrients are also present in low quantities.

The soils occur in finer-grained patches in the old alluvium. Their origin is due to clay translocation and probably spasmodic or rejuvenated profile truncation. Truncation of the profile after a prolonged period of stability and textural segregation would have the effect of preferentially removing much of the coarser grained material from the soil, leaving a medium- or finer-textured residue.

These soils belong in the Puletan Suite, even though they lack the sandy topsoils of the other subsuites. They correspond to the finer textured subdivisions of the Puletan Suite of Wright *et al.* (1959). The Hattieville Series of the Belize Valley survey (Birchall and Jenkin, 1979) covers a wide range of textures, and includes a clay phase. Its heterogeneity is especially apparent when individual profile descriptions are considered. The soils of the Backlanding Subsuite are clear analogues of the Bladen Subsuite in the Puletan soils of the Central Coastal Plain (King *et al.*, 1986; 1989). As with Boom, Savanna and Serpon it may later be appropriate to amalgamate the Bladen and Backlanding subsuites.

Backlanding soils are easily distinguished from the other subsuites in the Puletan Suite by their finer textured topsoils. Any Puletan soil that is sandy clay loam or finer, is automatically in Backlanding Subsuite. Many sandy loam topsoils also qualify, although where the textural discontinuity is deep, and where there is no sandy clay loam or finer texture within 70 cm, the soil would more appropriately belong to the Boom Subsuite. The only other possible confusion is with the soils of the Felipe Subsuite in the Revenge Suite. Felipe soils usually have less striking mottles in their subsoils, which are also less compact than those of the Backlanding Subsuite. Felipe soils also have limestone or a calcareous horizon at a depth of less than 2 m, whereas the soils of the Backlanding Subsuite have no immediate source of calcium.

Backlanding soils have low agricultural potential and are unlikely to warrant more detailed surveys. Subdivision into series should not therefore arise. Should it be required, separation is possible on the subsoil's degree of compaction and assumed permeability to water and penetrability by roots, as in the distinction between Bladen and Regalia subsuites in the Puletan soils of the Central Coastal Plain (King *et al.*, 1986). Topsoil texture may also be used as a criterion, but possibly only at phase level, as in the subdivision of Hattieville Series in the Belize Valley (Birchall and Jenkin, 1979).

The compaction and impermeability of the subsoils combine with the generally low nutrient status to impose severe limitations on crop performance. As can be seen in Table A2.3, the soils are assessed as generally unsuitable for all cropping systems except rice. They may be marginally suitable for pineapples and coconuts, provided that the subsoil is at the less compact end of the range.

Haciapina Subsuite

The soils of the Haciapina Subsuite occur in depressions and on lower slopes in the Pine Type of land systems as subunit pW. They are quite extensive in the Pine Ridge area north of Lemonal. The soils are found in the wetter parts of the Pine Ridge landscape, and generally have an open grass-sedge savanna vegetation. Any pine and crabboe trees present are scattered and stunted. The main tree components are palmettoes, which may be scattered but are more usually clumped into small thickets or as palisade-like hedges along the edges of swamps.

The main feature of the profile is the deep pale and wet sandy topsoil. The surface horizon varies considerably in colour and organic matter content from dark and rich, even slightly peaty in places, under palmettoes, to pale and poor under grasses and sedges. The surface horizon overlies a deep, pale and wet sandy horizon, with colours ranging from very pale brown through pale yellow to light grey or white. The bright yellow colours found in other Puletan soils upslope are absent. Textures are generally very coarse, ranging from sand to loamy sand, with occasional coarse sandy loams. The sandy horizon extends to a depth of 50-100 cm. It is wet for much of this depth and for much of the time. Saturated conditions persist longer in the topsoils of the Haciapina Subsuite than in any of the other subsuites in the Puletan Suite. The lower subsoil is brightly mottled red, white and yellow sandy clay loam-clay. It is similar to the mottled subsoils of the other subsuites in its intense compaction and impermeability. It may be drier than the overlying sand – often no more than moist to the touch.

Like the rest of the suite, the soils are moderately acid but very base-deficient. They are also low in other nutrients such as nitrogen, phosphorus and trace elements. The granulometric analyses show that the textural discontinuity although deep, is sharp and that clay content increases greatly over a depth interval of only a few decimetres.

The sandy upper horizons appear to be surface wash from the topsoils of the Puletan soils upslope. Lateral drainage especially as subsurface throughflow across the top of the mottled and impermeable lower subsoils, probably also accounts for the wetness of the sandy horizons in these soils. Because of their low-lying position, the inflowing water does not drain away easily, so that the topsoils stay saturated well into the dry season. However, the lower subsoils are so impermeable that little water penetrates and they are not saturated to the same extent.

The soils correlate well with the Haciapina Set of Wright *et al.* (1959), but the Haciapina Subsuite of the Belize Valley survey (Birchall and Jenkin, (1979) is much more widely defined and includes a considerable range of profile morphologies and vegetation types. The Haciapina Subsuite of this study appears to correspond with the Little Creek Series of the Belize Valley, and possibly some of the deeper, coarser and wetter soils in the Crabcatcher Series.

Correlation with the international systems is fairly clear provided that the textural discontinuity is not at a depth of more than 1.25 m, which is rare. In the FAO/UNESCO system the shallower profiles are Dystric Planosols, with a few of the darker-topped soils under palmetto clumps qualifying as Umbric Planosols. They are probably Albaquults, Ochraquults or Umbraquults in the USDA system. The soils with deeper sandy tops are Dystric Gleysols or Gleyic Arenosols in the FAO/UNESCO system and probably Psammaquents in the USDA system. Like the Crooked Tree Subsuite, these soils transgress boundaries at the highest taxonomic level in the international systems, but form a coherent and distinct group in their Belizean context.

The distinction of these soils from those of other subsuites is fairly clear. The wetness and invariably pale colour separate them from the soils of the Crooked Tree and Boom Subsuites. The associated grass-sedge savanna with palmettoes is also distinctive from the tree savannas usually found on those subsuites. There are no soils in Revenge Suite with such deep sandy, and wet topsoils. Revenge soils are also calcareous at depth.

The soils have low agricultural potential, so that detailed surveys and subdivision into series are unlikely to be required. If necessary, the depth of the sandy topsoil should be a useful criterion, in a similar manner to the distinction between the Crooked Tree and Boom Subsuites. The poor drainage, and low nutrient status impose severe constraints on plants and crops. As can be seen in Table A2.3, they are assessed as being moderately to marginally suitable for rice and only marginally suitable for pasture, pineapples and possibly coconuts. Their wetness makes them unsuitable for all other cropping systems. Drainage of many of these soils may be difficult, as they mostly occur in scattered depressions in very subdued topography. Others may be drainable, but will still be agriculturally poor because of the coarse textures and low nutrient status.

Buttonwood Subsuite

The Buttonwood Subsuite occurs mostly along the coast (subunit 'sl'), but small patches also occur inland, close to the margins of swamps fed by saline or brackish groundwater. The soils carry a characteristic variant of the Pine Ridge savanna, in which the distinctively foliaged silver buttonwood is the main or only tree component. Any pines or crabboo present are stunted and rarely overtop the buttonwoods at heights of 2-3 m.

Morphologically, the soils are rather heterogeneous, covering much of the range of the Puletan Suite. They have coarse- or medium-textured upper layers abruptly overlying red, white, yellow and brown mottled subsoils, which are much finer-textured and more compact. A common feature is a shallow, reddish, loose and puffy topsoil in place of the normal organically darkened surface horizon.

The distinctive feature of these soils is their salinity, generally easily distinguished in the field by tasting and because of the strong association with the unmistakable silver buttonwood tree. The salinity occurs throughout the profile, but may be more intense in the topsoil than at depth.

The salt may come from wildborne marine spume where the soils are found close to the coast, but it does not account for the patches far inland, such as along the middle stretches of the New Northern Highway. The salt for these topsoils must come from terrestial sources, probably saline springs. It is known that many inland swamps, such as Cobweb Swamp, are fed by quite saline sources (J. Jacob, 1990; personal communication) and some of the swamp water is distinctly brackish. It is certainly sufficient to support patches of mangrove.

The soils were not explicitly recognized in earlier surveys, but correspond with the subsuite of the same name in Stann Creek District (King *et al.*, 1989). They correlate with the salic phase of the Eutric or Dystric Planosols in the FAO/ UNESCO system. The salinity may not be intense enough for any horizons to qualify as salic in the USDA system, so that the salinity is not recognized in their designation as Albaquults, Albaqualfs, Paleaqualfs or Paleaquults. The soils are quite distinct from others in the suite on account of this salinity. The occurrence of the characteristic vegetation also aids their recognition in the field.

The soils may well be surveyed in great detail because, although of no agricultural use, they may be suitable for fish or shrimp ponds. Soil characteristics of importance include a salinity range of 25-28 parts per thousand; the degree of subsoil compaction and impermeability and any tendency for iron to be massively dissolved if part of the profile is inundated for long periods. These are the criteria that should be used to subdivide these soils into series or other detailed taxa.

At present, these soils are unused or have been dug for shrimp ponds. This is the only intensive form of land use that they can support. Their drainage, salinity and often poor nutrient status preclude them from any terrestial agricultural use, as can be seen in their permanently unsuitable assessments for all of the cropping systems considered in Table A2.3.

TINTAL SUITE

Tintal Suite soils are poorly drained for all or a considerable part of the year. Soil formation is dominated by the gleying processes associated with wet and reducing conditions. The soils are not defined in the terms of their parent materials, but most of them form in either long-distance alluvium or locally derived slopewash. They occur in low-lying positions. Four subsuites are identified:

(i) Pucte — Seasonally gleyed soils in slopewash deposits in the limestone areas. Fairly tall broadleaf forest with many pucte trees.

(ii) Chucum	Seasonally gleyed soils of depressions in limestone areas. Low akalche bush.
(iii) Sibal	Permanently waterlogged mineral and organic soils of freshwater swamps.
(iv) Ycacos	Permanently waterlogged mineral and organic soils of brackish and saline swamps.

Pucte Subsuite

Pucte Subsuite soils are widespread in the limestone areas in the north of the country. Individual occurrences are not generally large but they are so numerous that they probably total to a considerable area. They occur in slopewash deposits of variable depth. Their natural vegetation is fairly tall broadleaf forest, with a high proportion of pucte trees; hence the subsuite's name. Other common trees include red gombolimbo and some rather stunted sapodilla.

The surface often has hogwallow microrelief, with mounds 1-3 m in diameter and with microrelief up to 50 cm, although usually much less. These mounds were probably accentuated by overland flow, but soil faunal pedotubation may have caused the initial irregularities. Once created and enhanced, the mounds tend to be preferentially colonized by trees, the roots of which stabilize the mounds and provide a base for their further expansion. The evidence for intermound fluvial corrasion is indicated by the absence of forest floor litter in the intermound channels.

The topsoil is quite deep, often reaching a depth of 35-40 cm, and occurs under channels as well as mounds. It appears to be very fertile, with brown-dark brown unmottled colours, a moderate or strong crumb and porous structure, a very friable consistence and often contains earthworms. Textures vary from loam to light clay.

The base of the topsoil marks the upper level of waterlogged conditions in the wet season. The soil texture is usually heavy clay, although some clay loams are found. Matrix colours vary from grey-pale brown, with light greys and yellows also occurring. There is sometimes a tendency for matrix colours to become less grey with depth. The subsoils are blotched and mottled. There are faint to distinct diffuse grey-red patches, distinct dark brown-reddish brown linear mottles along existing or relict root channels, white patches of soft calcareous material, and some yellowish patches, which are possibly jarosite. The subsoils may contain fragments of limestone and well-crystallized gypsum.

The subsoil structure tends to be massive-coarse blocky or prismatic in the dry season, but more massive when wet. The dry season consistence is moderately firm. In the wet season the subsoils are quite soft and in some of them it is possible to push an auger right down without rotation and without removing soil. This is rare in mineral soils and is characteristic of young and unripe soils. The soils can vary considerably in depth. Some of them are deeper than 2 m, but in others the underlying limestone is encountered at a depth of less than one metre. The limestone may be soft and weathered, but in some profiles some kind of secondary recementation appears to have occurred, producing a pronounced and intact carapace, which appears to be younger and more active than those found under upslope soils, such as those of the Pembroke Suite.

Pucte soils are neutral-moderately alkaline. Base saturation is total, with calcium as the dominant exchangeable cation. Available and total phosphate contents are thought to be variable. Organic carbon and total nitrogen levels are moderate.

The soils are clearly seasonal gleys, with hydromorphic processes predominating; but the lack of a peaty top, the presence of earthworms in the topsoil, and the development of some subsoil structures indicates seasonal drying out of the upper part of the profile.

Charter (1941) describes a number of seasonally flooded soils developed in calcareous clays. The best match for our Pucte seems to be his Kinloch and possibly his Douglas Series. Pucte soils correspond well to the Pucte Set of Wright *et al.* (1959). In the Belize Valley, a range of seasonally flooded calcareous clays are classified as the Creek Subsuite. Of these, the Norland Series appear to be the closest equivalent to the Pucte Subsuite of the present study.

The predominance of gleying in these soils makes their correlation with the international systems fairly clear: Eutric or Mollic Gleysols in the FAO/UNESCO Legend and Tropaquepts in the USDA Soil Taxonomy.

The distinction between these soils and those of other subsuites are gradational. There are deep dark clays with mottling in the lower subsoil in the Louisville, Yalbac and Ramgoat subsuites which grade into the Pucte Subsuite. Where clear gley features occur at or above a depth of about 70 cm, the soil is considered part of the Pucte Subsuite. Where the gley features are found below that depth, the soil belongs to the other subsuites. The distinction from the Chucum Subsuite is also gradual. The Pucte Subsuite soil occurs under a distinctive medium-high forest, whereas the Chucum Subsuite soils occur under low akalche scrubby bush. The Chucum soil profile tends to have darker matrix colours and less prominent mottles. The soils of the Sibal Subsuite are perennially wet and have less pronounced microrelief, topsoil crumb structures and mottling.

Pucte Subsuite soils do not warrant detailed surveys for their own sakes, but might be included in the margins of surveys of the better soils upslope. If they are to be subdivided into series, drainage and depth are likely to be the most useful criteria. Many of these soils have been recognized as having severe drainage problems and have therefore been left uncultivated both by subsistence smallholders and commercial cane farmers; there appears to be an increasing tendency to encroach onto these soils at the bottom margins of new or enlarged cane fields.

The obvious and main constraint on their potential as indicated in Table A2.3 is the poor drainage. Cane growth and yields are visibly lower on these soils than on those upslope. If they are drained, chemical characteristics suggest they will be reasonably fertile. The potential for drainage depends on the local juxtaposition of water tables, the potential sump and the slope gradient between them. Close drain spacing will probably be necessary because of the finer textures and relative impermabilities of the subsoils. Alternatively, crops adapted to wet soil conditions, especially rice, could be considered.

Chucum Subsuite

Chucum Subsuite soils occupy enclosed depressions in limestone terrain in Northern Belize, particularly the Neustadt Swamps land system. They are less extensive than the soils of the Pucte Subsuite. The depressions are thought to be related to percolation voids in the underlying limestone and to act as centripetal sinks for intermittent overland flow and throughflow that runs off surrounding areas. The natural vegetation of these soils is akalche bush, which is low stature woodland with a high proportion of microphyllic and thorny tree species. Chucum, logwood and stunted pucte and sapodilla trees are common components.

The surface of these soils sometimes has hummocky microrelief, though this is generally less prominent than in the Pucte soils. The underlying profile mainly consists of fairly deep dark grey or dark greyish brown clay. The topsoil may be almost black, but lacks the intensity of colour of the better-drained black clays upslope. Its structure is fine or medium blocky and the consistence is fairly firm. The subsoils are greyish with common faint or distinct brown, reddish brown and yellow mottles. The structures in the profile examined in detail (see Profile OZ 71 in Appendix 3) are strongly developed, grading from spectacular coarse prismatic to coarse blocky-wedge at depth. The subsoil peds have marked coatings on their faces, which may include a contribution from argilluviation, but pressure coatings are also formed, as indicated by the slickensides on the oblique faces in the lower subsoil. There are frequent patches of soft limestone in the subsoils, and gypsum crystals are commonly found at depth. Depth to the underlying limestones is usually more than one metre.

The soils are alkaline and completely base-saturated, with calcium as the main exchangeable cation. Organic carbon and total nitrogen levels are low-moderate. Phosphate levels are moderate.

The clays have collected in the depressions by wash from surrounding areas, and possibly also by rather faster solution of the limestone than elsewhere, which would produce *inter alia* the large dolines of the Neustadt Swamps land system. The clay tends to plug the effect of the solution void, so that water drains only slowly. For much of the wet season water tables are high, with some spells of surface water. Hydromorphic soil processes predominate. In the dry season, the water table drops, the clays dry out and contract, giving the marked coarse structures in the subsoil.

The placement of these soils in the Tintal Suite is disputable. When seen in the dry season, the soils appear dry and only imperfectly drained, but the natural vegetation, especially the presence of chucum and logwood trees, indicates prolonged wet spells.

Charter (1941) described a number of soils that appear to correspond to the profile and vegetation characteristics of these soils. His Turner Series appears to be closely equivalent, with his Kinloch series as the gypsiferous variant. His Cave Series is a darker coloured and more hummocky soil that would also be included within the Chucum Subsuite of this study. Some of the drier, palmetto-covered soils of his Sarawe and English Creek Series are also similar to the Chucum Subsuite, as used here. The Chucum Set of Wright *et al.* (1959) is equivalent to the Chucum Subsuite of this study. The Bobo clays are somewhat similar, but they occur in the depressions in the more pronounced limestone karst topography of Southern Cayo. The Belize Valley survey also identified similar soils as their Chucum Subsuite (Birchall and Jenkin, 1979).

In assigning these soils to taxa in the international systems, the hydromorphic features are considered more important than the coarse structures and slickensides in the subsoils. They are therefore tentatively designated as Eutric Gleysols (FAO/UNESCO) and Eutric Tropaquents in the USDA Soil Taxonomy, but they could be assigned to vertic subdivisions of these soil units or groups.

The soils are mottled and seasonally waterlogged at much shallower depths – often almost to the surface – than the mottled variants of the Louisville, Yalbac and Ramgoat subsuites. The akalche vegetation is also quite distinctive. It also differentiates Chucum from Pucte Subsuite. In addition, the Pucte soils have a more pronounced hummocky surface, a distinctive friable crumb-structured topsoil and less vertic features in the lower subsoil. Chucum soils can be distinguished from Sibal soils by the latter's permanent waterlogging and gleying.

The soils have little agricultural potential, and are unlikely to warrant detailed soil surveys. Subdivision into series is therefore unlikely to be necessary. In case it should, depth to and duration of waterlogging are likely to be the most useful criteria.

The akalche bush is not the original vegetation because these areas were a source of logwood which was extracted in large volumes. The reserves of logwood are now much diminished, but there are signs of a modest revival in the trade. The soils impose several physical constraints on plants and crops. During the wet season, waterlogging and anaerobiosis inhibit root penetration and function. The rooting depths for water and nutrient extraction in the dry season are therefore limited. All crops, except possibly rice, have a very limited potential. This low assessment is reflected in the suitability ratings in Table A2.3.

Sibal Subsuite

The Sibal Subsuite contains the permanently waterlogged mineral and organic soils of freshwater swamps. The natural vegetation ranges from swamp forest (subunit 'h') to completely open herbaceous associations of sedges, rushes and water lilies (subunit 'l'). Most of the soils have a wet peat or muck surface, which may extend to a depth of 50 cm or more, usually as a semi-fluid material. In other soils, the organic layer is fairly shallow and overlies grey, wet, virtually unmottled, mineral soil. Clays and silty days are the commonest textures but some sands also occur. The soils are usually structureless and the consistence is soft or loose, depending on texture. The pH is normally about neutral in the mineral layers, but the organic material may be quite acid.

Charter (1941) appears to make a distinction in these soils between the calcareous Yo Creek Suite and those on siliceous (the wetter, sedge-covered soils of Sarawe Suite) parent materials. Wright *et al.* (1959) distinguish a number of freshwater swamp soils, mainly on the basis of texture. They mostly belong to their Sibal and Caway sets. Birchall and Jenkin (1979) defined a Swamp Suite in the Belize Valley to cover the Sibal Subsuite soils of this study.

The classification of the Sibal Subsuite soils in international systems depends on whether they have sufficiently deep organic topsoils to be Histosols (both FAO/UNESCO and USDA). If not, they are various kinds of Gleysols in the FAO/UNESCO Legend and Fluvaquents in the USDA Taxonomy.

The Sibal Subsuite is easily disinguished from other subsuites, by the waterlogged and characteristic freshwater swamp vegetation. The soils are unlikely to merit detailed surveys for development purposes, and therefore subdivision into series seems unlikely to be needed. However, the subsuite is so heterogeneous that it can easily be subdivided on the basis of depth of peat, texture, and intensity and depth of inundation.

The soils are currently unused, but they may have been incorporated into some of the raised and canalized fields of the ancient Mayas (e.g. Darch, 1981).

The agricultural potential of these soils is severely constrained by the very poor drainage. The soils are too wet for too long, even for rice. Their drainage on a large scale is likely to be difficult because of the absence or shallowness of potential outfalls. Where drainage is possible, crops such as rice are likely to be the most feasible.

Ycacos Subsuite

Ycacos Subsuite contains the deeper permanently wet mineral and organic soils of mangrove swamps. They mainly occur in coastal and pericoastal swamps (Toledo and Corozal saline swamps land systems), but small patches are also found well inland where a swamp is fed by a saline or brackish spring. The characteristic natural vegetation is mangrove, but includes a heterogeneous set of associations, the distribution of which is largely determined by the inundation frequency and the salinity of the flood waters (see Appendix 6).

The soils vary in texture and depth, but the subsuite excludes the very shallow soils. There are some organic soils but most of them are grey silts and clays, which are wet, structureless and of soft consistence. They are not usually mottled but may have yellow jarositic patches. Some of the soils contain abundant gypsum as well as more soluble chloride and sulphate salts.

The dominant chemical characteristic is the salinity. This varies from moderate to extremely high; but it is not usually accompanied by sodicity, and calcium and magnesium are dominant exchangeable cations. Soil reactions are moderately alkaline.

The soils are very young: pedogenesis has hardly begun. In many cases, the parent material is still accumulating.

Charter (1941) separated the soils into three suites – Sibun, Burdon and Haulover – mainly on texture. Other surveys have tended to group them together as the Ycacos Set (Wright *et al.*, 1959) and the Ycacos Subsuite in the Swamp Suite (Birchall and Jenkin, 1979).

As with the Sibal Subsuite, some of the soils may have deep enough organic upper layers to qualify as Histosols in both the FAO/UNESCO and USDA systems, but the bulk of them are mineral soils, and are Gleysols (FAO/UNESCO) and Tropaquents and Tropaquepts (USDA). The presence of jarosite suggest some of the soils are potential acid sulphate soils, if drained, and may therefore fall into Thionic or Sulf subdivisions.

The soils are unlikely to be surveyed in detail, but if series do need to be defined, peat depth, texture, inundation regime and salinity are probably the most useful criteria.

Most of the soils are largely unused, except as fishing grounds and a source of certain timber species for the construction industry, expecially for piling; but there are developments on some of these soils for mariculture and residential/recreational purposes. As both of these involve removal of the mangrove, they increase the liability of the sediment to removal by wave action and longshore drift. They also render the cleared area and its hinterland more vulnerable to hurricanes.

These considerations should be taken fully into account before developing these soils further. Their agricultural potential is negligible because of the limitations of poor drainage, flood hazard and salinity. There is a case for retaining these soils as natural wildlife reserves/hurricane buffers.

BAHIA SUITE

The Bahia Suite includes very young and shallow soils formed on low and recently emerged limestone in the vicinity of Chetumal Bay. The soils are most extensive on the northern shore, between Corozal and Consejo, but also occur on the southern shore, to the west of Sarteneja. Their total area is not large. There are two subsuites:

(i) Consejo — Shallow black peat, muck, or humose loam over weathered gypsiferous limestone;

(ii) Remate — Shallow stony clays over hard massive or fragmented coral rock.

Consejo Subsuite

The soils of the Consejo Subsuite mostly occur in the Consejo Plain land system on the low coastal platform between Corozal and Consejo. Very small pockets were seen at Warrie Bight and are assumed to occur elsewhere along the southern shore of Chetumal Bay. The natural vegetation is mostly low broadleaf forest containing many black chechem, pucte, and chucum and is probably post-hurricane secondary regrowth. Considerable areas have now been cleared.

The soil profile consists of shallow black, rather dry but very decomposed peat, muck or humose loam overlying slightly weathered coral gypsiferous limestone, usually at a depth of less than 30 cm. There is often an intervening layer of really hard fragments of non-gypsiferous coral with interstitial grey clay immediately beneath the peat, but in some profiles this is absent. The fragments are probably remnants of the case-hardened carapace that mantled the limestone upon its emergence. The limestone beneath the stone layer may be soft enough to quality as a gravelly type of sascab, but it becomes rapidly harder with depth.

The surface horizon has a slightly alkaline pH. Many have only moderate organic carbon and loss on ignition values, and qualify as humose loams rather than mucks (>35% loss on ighition). The subsurface horizons are alkaline, base-staturated and calcium-dominated. However, the source of the calcium is gypsic rather than carbonatic (see Profile OZ 45 in Appendix 3). Soil formation is attributed to moderate impermeability of the very flat-lying, unjointed and unfractured limestone. Drainage is sufficiently poor to retard decomposition of organic matter, but not bad enough to prevent forest growth and production of litter. The poor drainage also accounts for the persistence of the gypsum.

The soils are grouped with the Remate Subsuite because of their proximity and common origin from recent limestone. They correlate well with the Consejo soils of Charter (1941) and Wright *et al.* (1959). In the international systems they lack sufficient depth and organic carbon in the surface horizons to qualify as Histosols. They therefore qualify for the young and weakly developed groups – Cambisols (FAO/UNESCO) and Inceptisols (USDA), with qualifiers for their calcareous, gypsiferous and humose characteristics.

The soils are quite distinct in Belize. The other peats are in the Sibal and Ycacos subsuites of the Tintal Suite. These are deep, very wet and carry distinctive types of swamp vegetation. Other shallow soils over limestone lack distinctly peaty or humose surface layers and such high contents of gypsum.

Suggested criteria for subsuite subdivision into series are: the depth and organic matter content of the humose topsoil, the presence or absence of a hard carapace stone layer, and the hardness and gypsum content of the underlying sascab. However, mapping for agricultural development is unlikely to be necessary.

The soils have severe limitations for plant growth and agriculture. For much of the year the flat-lying and unjointed limestone prevents free drainage and the soils are saturated for long spells. The shallowness of the actual topsoil and the impenetrability of some of the stone lines and underlying sascab preclude deep rooting. Vegetation is therefore under moisture stress during prolonged dry spells. The underlying gypsum and limestone can lead to a poor balance of nutrients.

At present some of the soils are used for sugar cane and coconuts, and there are some areas of extensively managed pastures. The agricultural potential is low, but this is unlikely to be a serious problem because much of the area will probably be developed for residential and tourist accommodation.

Remate Subsuite

The soils of the Remate Subsuite are shallow and stony clays developed over recently emergent, massive or fragmented coral on the low areas around Chetumal Bay. They are equally widespread on both southern and northern shores. The subsuite also includes the very shallow and stony clays that occur as linear bodies on low ridges of protuberant coral, mostly fragmented, on the slightly higher and presumably older levels of the Xaibe Plain Land System. The soils originally carried a low broadleaf forest, with many chechem, red gombolimbo, and stunted sapote. In much of the Xaibe Plain in northern Corozal District, the forest has been cleared for sugar cane cultivation, but much turbed forest remains in eastern Corozal District.

The profile is simple and shallow: mainly stony clay, becoming rapidly stonier with depth until massive or bouldery limestone predominates, generally within 30 cm or shallower. The clay may vary in colour from black through dark grey – dark brown – brown to red, according to the iron content of the parent material. In general, the coastal Remate soils are blacker; whereas those in the Xaibe Plain are redder, but there is much local variation.

The soils are neutral to alkaline and fully base-saturated, almost entirely with calcium. Organic matter contents and therefore nitrogen and available phosphorus levels are quite reasonable, but the redder and more oxidic soils are likely to have significant phosphate fixation capacity.

These young soils are weakly developed. The coastal gravels are presumably storm remnants of former reefs and beaches. The low linear gravel bodies in the

Xaibe Plain lie slightly above the rest of the plain. They may be the edges of old coral platforms that have been comminuted by subaerial weathering since emergence. Alternatively, they may have emerged as already fragmented remnants of old storm beaches.

The soils correlate clearly with the Remate sets of Wright *et al.* (1959). They are also relatively easily placed in the FAO system, as various kinds of Leptosols. In the USDA Soil Taxonomy, their placement is more problematic because shallow stoniness *per se* is recognized at quite a low level – the Lithic subgroups. The placement of these soils at a higher level therefore depends on the designation of the less important interstitial materials: they probably qualify as Lithic Eutropepts or Rendolls.

The most likely confusion in soil recognition in Belize is with the shallower and stonier variants in Louisville, Concepcion and especially Xaibe Subsuites. No quantitative definitions have yet been formulated, but the Remate soils are generally stony throughout and cannot be augered beyond about 20-30 cm. The stony variants of the other subsuites have lower stone densities in the surface layers, and the stones tend to be softer and more weathered.

Where these soils predominate, detailed soil surveys and therefore definition of soil series are unlikely to be necessary. Detailed soil studies have already been conducted in the Xaibe soils (e.g. Christiansen, 1986), but the proportions of Remate soils in these areas are small, so that their subdivision is unnecessary. Should series definitions be needed, colour is likely to be the most useful criterion, as indicated by Wright *et al.* (1959), but for some crops a distinction between shattered and massive limestone may be more useful. Where extensive, the soils are largely avoided by farmers, except for some low intensity cultivation of coconuts and pineapples. Where they occur as pockets in the deeper Xaibe soils, some have been incorporated into fields of sugar cane, fruit trees and irrigated vegetables.

The soils have severe limitations in moisture storage capacity and crops are likely to be under considerable moisture stress in dry weather. The stoniness causes severe problems in a wide range of field operations, especially cultivation. Considerable fertilizer inputs will also be needed because of the low volume of rootable fine earth. Their potential for most crops is therefore low. Some of the soils are moderately suitable for coconuts and pineapples but, even for these crops, some of the soils will be too droughty. Avocadoes may thrive. They are grown at Remate village and on similarly shallow and stony soils in Mexico. Otherwise only sorghum, sugarcane and coffee (Robusta), are even marginally suitable, and only in the best patches.

PEMBROKE SUITE

The Pembroke Suite includes all of the deeper, well- and imperfectly drained clays overlying the Late Cenozoic limestones of Corozal District and parts of northern Orange Walk District. Features common to all soils in the suite include fine textures throughout, preponderance of cracking smectoid clays, neutral or alkaline pH and complete base saturation, usually by calcium. The suite includes some of the most fertile and intensively cultivated soils in the country. There are also areas of these soils in eastern Corozal District that are virtually uninhabited, inaccessible and unused. There are four subsuites:

(i) Louisville — Black or dark grey. Variable depth and drainage;

(ii) Concepcion — Dark brown or brown. Variable depth and drainage;

(iii) Xaibe — Red. Variable depth and mostly well-drained;

(iv) Puluacax — Yellowish and mottled. Variable depth and mostly imperfectly drained.

Louisville Subsuite

The soils in the Louisville Subsuite are black clays developed over limestone on the Louisville Plain land system. They have been much favoured for agriculture since Mayan times, and are now mostly cleared for sugar cane. Remaining uncleared pockets and earlier reports indicate that the natural vegetation is a moderately high semi-deciduous broadleaf forest with many cohunes over most of the area, with a lower forest with more pucte trees and botan palms on the deeper and less freely draining soils on lower slopes (subunit 'W').

There is considerable morphological variation within this subunit. Over much of the area the soils are quite shallow. The shallower profiles consist of a black or very dark grey clay topsoil with a medium or fine blocky structure, overlying a dark grey or grey clay with a coarser blocky structure and firm consistence. The blocky structures have shiny clay coatings which are probably pressure faces rather than illuvial clayskins. The soil overlies weathering limestone, usually at 25-50 cm depth. The limestone is often capped with an almost continuous layer of greyish harder rock, sometimes fragmented to form a stone line. It probably represents remnants of a case-hardened carapace. The underlying weathering limestone is very pale, often white, and has a crumbly, friable consistence. It can be hand textured and usually falls in the silty loam-clay loam range. In places, fragments of harder materials feel like sand grains. This material, known locally as sascab when not too coarse-textured, may extend to well over 2 m in depth before coming appreciably harder.

The rather deeper modal Louisville (e.g. Profile OZ 52 in Appendix 3) has a similar morphology but may have a light grey or pale brown, slightly moister and less strongly structured clay horizon just above the carapace or sascab, which occurs at depths of 40-70 cm. There are also deeper Louisville soils, without any gleying, where the weathering front is depressed or where soil material has accumulated by local wash or creep. They are similar to the modal soils but the sascab may begin at a metre or more.

However, most of the deeper soils occur on lower slopes close to swamps or around depressions, and are characteristic of subunit 'W'. They are less well-drained and the subsoil clay is noticeably wetter, moderately or strongly mottled, and may contain substantial amounts of crystalline gypsum. The structures in the lower subsoils are mostly coarse blocks, with some tendency to wedges, often with shiny and striated oblique faces, which are probably shear-induced slickensides. These deep mottled Louisville soils are associated with the lower stature forest with much pucte and botan.

All of the soils in the subsuite are alkaline and fully base-saturated throughout, with calcium as the dominant exchangeable cation. Textures are clay throughout, with little variation in clay content with depth and little indication of clay movement. The clay minerals are probably predominantly smectoid: the soils can crack considerably when dry. The dark soil colours are produced by the interaction of calcium, smectoid minerals and organic matter. They do not necessarily indicate very high contents of organic matter, which are quite variable. Nitrogen and available phosphate levels are also variable but are often moderate or better.

Most of the soils have probably been formed by *in situ* weathering of the limestone and any additional material such as minor inputs of volcanic ash. Leaching is constantly countered by further solution of limestone and injection of calcium into the soil system. The deeper soils have accumulated by later movement of soil material by wash or creep, although both are minor processes in these very gently sloping landscapes. The deep mottled soils are affected by seasonal waterlogging and reduction of iron. The gypsum in the lower horizons probably derives from sulphates in the limestone. Its retention is due to the restricted movement of water rather than the aridity of the climate.

This subsuite correlates clearly with the main series in the Louisville Suite of Charter (1941) and with the Louisville Subsuite of Wright *et al.* (1959). Its morphological range makes correlation with the international systems more difficult. The shallowest soils probably qualify as either Rendzic or Vertic Cambisols in the FAO/UNESCO system and Rendollic or Vertic Eutropepts in the Soil Taxonomy. The deeper soils are probably Rendolls in the Soil Taxonomy, grading through to Pelluderts in profiles with slickensides and gypsum. In the FAO system the range of Vertic Cambisol to Pelli-Eutric Vertisol probably encompasses the whole subsuite.

The Louisville soils are distinguished by their colour from the other subsuites within the Pembroke Suite. The deeper mottled Louisville soils grade into the wetter and more gleyed soils of the Pucte and Chucum subsuites of Tintal Suite, but these latter soils are mottled to the surface, wet in the subsoil for most of the year and carry distinctive swamp types of forest.

The most difficult demarcation is from the dark clays of the Yalbac Subsuite in Yaxa Suite on the older limestones to the south. There is little to distinguish them in colour, texture and range of depths and drainage. The Louisville soils tend to have finer and less pronounced blocky structures in the surface horizon and crumble more easily when dry. Their underlying limestone tends to be more intensely and deeply weathered. Based on a limited number of chemical analyses, the Louisville soils appear to have higher levels of nitrogen, available phosphate and potassium, although these nutrients are variable in both subsuites, and the ranges overlap. The main reason for separating the two groups is geographical. They occur in different areas and environments, appear to support slightly different vegetation, and to have somewhat different agronomic characteristics. Although ill-defined, the distinction is retained for the present.

Charter (1941) subdivided the dark clays of his Louisville Suite that occur in Corozal District into three series; mainly on the presence, absence and fragmentation of the carapace layer. Wright *et al.* (1959) distinguished four sets on drainage, stoniness and depth, which seem to be the most appropriate criteria for future series definitions.

The soils are largely used for sugar cane. Most of the sugar cane supplied to the Pembroke Hall mill in 1930s and 1940s was grown on the these soils, some of which appear to have produced satisfactory cane crops almost continuously, with little or no fertilizer for decades. The soils also produce good pastures and tree crops. They have high inherent fertility but benefit from fertilizer applications, especially N and P. Although many of them are pedologically shallow, they appear to have adequate reserves of available moisture. The carapace layer is sufficiently fragmented to allow root and water penetration and the underlying sascab is soft enough for free rooting and is exploited by tree and sugar cane roots for moisture and probably some nutrients. The soils are moderately well-drained except for the deep, mottled variant.

The soils have been assessed as being moderately or marginally suitable for a variety of field crops, including sugarcane, cereals and beans. Apart from coconuts they are not so highly rated for tree crops. Lime chlorosis and possible droughtiness probably limit the potential for citrus. Fine textures and compaction preclude cashew, and cacao is probably limited by climatic and soil aridity. Nonetheless the soils are adaptable and potentially productive, and are among the best in the project area.

Concepcion Subsuite

The brown calcareous clays of the Concepcion Subsuite are intermediate in colour and other properties between the black clays of the Louisville and the red clays of the Xaibe subsuites. They are not generally extensive, often occurring as pockets within large areas of the darker Louisville soils; but there are considerable tracts in the Concepcion-Caledonia area of the Corozal District. The soils occur on the very gently undulating Louisville Plain land system. They are found in most topographic positions except for swamps and drainage lines. They are now mostly used for sugar cane and have been cleared for decades. Remnant vegetation patches suggest their natural vegetation is similar to that on the Louisville soils: semi-deciduous broadleaf forest with many cohune palms.

The distinctive feature of these soils is their dark brown-brown coloration. The topsoil is usually very dark brown but grades into lighter colours beneath. In other respects the soils are very similar to those of Louisville, with uniform clay textures, fine blocky, crumb or granular structures in the topsoil and coarser blocky structures below, usually with clay pressure faces. As in the Louisville Subsuite, the topsoil is moderately friable but the subsoil is firm.

There is a considerable range of depth and drainage within the subsuite, but most of the soils are shallow with limestone at depths of less than 50 cm. These shallow soils invariably have an intact or fractured carapace of hard limestone before the softer sascab is reached. The carapace is more widespread and generally thicker than in the equivalent shallow Louisville soils.

There are intermediate soils with similar morphologies, but the brown subsoil is deeper, overlying the hard limestone carapace at depths of 40-80 cm. There are a few even deeper soils, both mottled and unmottled; but they are much less frequent and extensive than in the Louisville Subsuite. The deep profiles on the lower slope and swamp margin sites in the Concepcion-Caledonia area tend to be dark grey or black and belong to the deep mottled soils of Louisville rather than Concepcion Subsuite.

The soils are all moderately alkaline (pH 7-8.4 in water) and fully base-saturated, with calcium as the main exchangeable cation. The granulometric analyses confirm the clay field textures, and that clay contents do not increase greatly with depth.

These soils are probably mainly derived from the solution residues of the limestone. The brownish colours are attributed to small quantities of free iron sesquioxides, which may have come from ferruginous impurites in the limestone or from subsequent aeolian or marine additions.

The separation of these soils at subsuite level is problematical. In previous surveys and classifications, they were treated as brown variants of the Louisville clays (e.g. Wright *et al.*, 1959). Their distinction here is due to their extent in the type area and somewhat different agricultural use and potential.

In the international systems the soils fall between major taxa. In the FAO/UNESCO system, a few of the shallower profiles are probably Rendzic Leptosols, but most of the subsuite are Eutric Cambisols. In the USDA Soil Taxonomy, the shallower soils are probably varieties of Eutropept, whereas the deeper soils may qualify as Rendolls, albeit slightly Chromic.

The soils are distinguished from those of the Louisville Subsuite in being browner than 7.5YR 3/2 in the subsoil; and from those of the Xaibe Subsuite in being browner than 5YR 5/4. As in the Louisville Subsuite, the most difficult identification problem with these soils is the distinction from the dark brown clays in the Yalbac Subsuite on the older limestones to the south. The Yalbac soils tend to be more coarsely blocky structured and less friable in the topsoil than Concepcion soils, but these are minor differences and the main distinction is geographical.

Conception Subsuite can be divided into series on the basis of depth and stoniness. Because of the scarcity of deep mottled soils, drainage is a less useful criterion.

The soils are now mostly used for sugar cane, although there are a number of fruit trees around the village of Concepcion. The village used to be known as the main producer of citrus in the north of Belize. The citrus trees were grown for the fresh fruit market, and never in sufficient quantities to support a processing plant.

The main crop limitation is a tendency towards droughtiness because of the generally shallow depths. There may also be nutrient deficiencies. In particular, phosphorus is likely to be somewhat deficient, due to some fixation by the ferruginous sesquioxides. The reputation of these soils for citrus is reflected in the assessments in Table A2.3. Compared with the black clays of the Louisville Subsuite these soils are favoured for most tree crops but downrated for arable crops.

Xaibe Subsuite

The red calcareous clays of the Xaibe Subsuite are important and extensive soils in Corozal District, with large areas in both the northern and eastern parts. They occur in all parts of the gently undulating Xaibe Plain land system except in the depressions and occasional drainage lines. They are particularly concentrated on the higher levels in these areas, where the landscape appears to be very slightly stepped. The natural vegetation is low-moderate semi-deciduous broad-leaf forest in which sapote, mahogany and black chechem are prominent. The mahogany in these forests in eastern Corozal District is slow-growing and relatively stunted, but is highly prized for the figure of its timber.

The profile morphology is faintly simple. The shallow topsoil is dark brown or dark reddish brown clay, with a fine blocky or granular structure, and slightly friable-firm consistence. It overlies a red clay with moderately strong blocky structures, the faces of which have shiny clay pressure coatings. The consistence of the subsoil can be very firm, almost compact, especially in deeper profiles. The subsoil overlies limestone, usually with a carapace of fractured hard rock over softer weathered sascab.

Depths are variable but shallow soils predominate. The hard carapace limestone is frequently found within 50 cm of the surface. The carapace appears to be particularly thick, and comprises coarse hard and angular fragments in the Xaibe clays of northern Corozal District, which are interspersed with the shallow stony soils of the Remate Subsuite. Shallow stony clays also predominate in the Xaibe soils of eastern Corozal District but there is a higher proportion of deep soils there, e.g. Profile 0Z 20.

Chemically, the soils are neutral to moderately alkaline and fully base-saturated. Organic matter levels are quite high (e.g. Profiles OZ 8, OZ 20, and OZ 24) – certainly much greater than indicated by the weakness or absence of dark colouration. The melanizing effect of the organic matter is masked by the dominant red colours of the free ferruginous sesquioxides. Total phosphate levels are moderately high, but the sesquioxides have a substantial fixation capacity.

Granulometric analyses confirm the clay field textures. In the deeper soils (e.g. Profiles OZ 20 and OZ 24), the clay contents are extremely high (>70%). Both profiles show increases in clay content with depth, so that the fine earth fractions of the subsoils consist of over 90% clay.

The main pedogenetic query about these soils is the source of the iron. The bulk of the soil is derived from impurities residual after the solution of the limestone. The iron is assumed to be an impurity in the limestone. Wright *et al.* (1959) suggested a volcanic origin, possibly windborne ash when the limestones were deposited. It is noticeable that the main areas of ferruginous limestone, and hence Xaibe clays, are close to Chetumal Bay. In such a situation it is possible that floating volcanic ash was concentrated by onshore wind and wave action, so that it was deposited on and incorporated into the corals and other marine calcareous organisms that were lithified into limestone. Volcanic ash may also have been deposited after the formation and emergence of the limestone, and been mixed with solution residues to form these soils.

The soils are prominent in Corozal District and have been recognized and studied since the first surveys, with the same name Xaibe passing from Charter (1941) through Wright *et al.* (1959) to recent studies such as Christiansen (1986) and our own.

In the international systems of classification, the soils are divided according to their depth. The shallower profiles are Chromic Cambisols in the FAO/UNESCO system, and probably some kind of Eutropept in the USDA system. The deeper soils are sufficiently weathered and show enough of an increase in clay content with depth to qualify as Chromic Luvisols (FAO/UNESCO) or Rhodudalfs or Rhodic Kandiudalfs (USDA).

The distinction of these soils from those of the other subsuites in the Pembroke Suite is quite clear, with the reds of the Xaibe Subsuite contrasting with the browns of the Concepcion Subsuite and the yellows of the Puluacax Subsuite. A more problematical distinction is with the red calcareous clay of the Chacluum Subsuite in the Yaxa Suite, developed over older limestones to the south. Visually and chemically there is not a great deal of difference, although the Xaibe soils tend to be shallower, stonier and drier. The main difference is geographical, with the Chacluum Subsuite occurring in a wetter climate and carrying a considerably higher stature forest. Unlike the Louisville and Yalbac dark calcareous clays, there is no transition zone in the red clays, as there is a gap of over 40 km without red calcareous clays between areas of Xaibe and Chacluum soils. The obvious criterion for subdivision into series is depth, as this is of considerable pedogenetic, taxonomic and agricultural significance.

Current use of these soils is very variable. In northern Corozal District, they have largely been cleared of their natural vegetation, and are mostly under sugar cane, but they are also used for irrigated winter vegetables and papaya, pineapples and fruit trees. The extensive tract of these soils in eastern Corozal District is largely uninhabited. Much of it remains under forest, although greatly disturbed by old mahogany logging, chicle gathering and hurricanes. Logging has recently been revived, with a considerably wider range of secondary hardwoods now being harvested. In Little Belize, large areas of Xaibe clays have been cleared for maize production and pastures by the Mennonite community. This cultivated area is still expanding.

The main limitations to crops on these soils are the droughtiness of the shallower profiles, and the tendency to phosphate fixation. Potassium can also be deficient in some of these soils. Nonetheless the soils are adaptable and potentially productive. Table A2.3 shows that they have been rated as moderately – marginally suitable for a range of arable crops, except cotton and rice, and for the more drought-tolerant tree crops such as coconuts. They are assessed as highly suitable for pineapples.

Puluacax Subsuite

The imperfectly drained yellowish calcareous clays of the Puluacax Subsuite are minor soils, which occur only in inaccessible parts of eastern Corozal District. Their extent will not be fully known until the area becomes more accessible.

The soils seen are found in imperfectly drained low-lying areas and on the margins of swamps, characterized by subunit 'W'. Redder and better-drained clays of the Xaibe Subsuite often occur upslope. The natural vegetation is low, stunted, broadleaf forest with a high proportion of pucte and chechem trees, and with small botan as the main palms. There are also areas of low dense tinta bush. There may be sufficient light at the forest floor to permit a herbaceous ground cover, in which cutting grass is locally important.

These soils were seen in only one profile (OZ 19), so their morphology is not well known. The shallow topsoil is dark grey or greyish brown clay-clay loam, with a moderate fine blocky structure. It overlies an olive or brownish yellow clay subsoil, often with reddish and grey mottles. The lower part of the subsoil contains many soft black ferrimanganiferous stains, some of which are indurated to form concretions. The subsoil may directly overlie hard limestone, or it may become increasingly grey mottled, so that eventually the matrix colour is light grey. Even in the deeper soils, limestone is usually encountered at depths of less than one metre. These soils are moderately alkaline and fully base-saturated. Some topsoil organic matter levels are moderate.

The soils appear to be imperfectly drained equivalents of the Xaibe clays. They originate from the same ferruginous limestones, but their free iron sesquioxides are more hydrated, producing the yellower colours. The presence of the soft and active black ferrimanganiferous concentrations is also attributed to the fluctuating water regime, although proximity of limestone appears necessary for, or at least conducive to, their formation.

The taxonomic status of these soils is problematical. They have been included in this suite as the Xaibe equivalent of the mottled variants of Louisville, but the wetter of these soils, especially those with akalche-like tinta bush, are similar to the seasonal gleys of the Pucte and Chucum subsuites in the Tintal Suite.

Some of the Maskall Series in the Xaibe Suite of Charter (1941) appear similar to the Puluacax clays. Wright *et al.* (1959) put their Puluacax Set into their Louisville Suite; so they also stressed the calcareous clay rather than the impeded drainage characteristics of these soils.

Placement in the international systems depends on drainage. In the FAO/UNESCO system, most of them are Chromic Cambisols, but the more poorly drained and less brightly coloured of them are Gleyic or Eutric Cambisols. In the USDA system they are mostly Eutropepts, with a few of the worst-drained qualifying as Tropaquepts.

The distinction of these soils from those of other subsuites is unclear. As already noted, they grade towards the seasonal gleys of the Pucte and Chucum subsuites, but Puluacax soils are normally yellower to greater depths, i.e. rarely grey in matrix colour at a depth of less than 50 cm, whereas gley features are shallower in Pucte and Chucum subsuites. Puluacax soils are also shallower, often with limestone at a depth of less than 50 cm. There are soils in the Pixoy and Jobo subsuites of the Guinea Grass and Altun Ha suites respectively, that have yellow calcareous clay subsoils similar to Pulucax soils; but their topsoils are generally coarser textured, often no finer than sandy clay loam. Jobo soils also have abundant flints, which are not found in the Pulucax clays.

So few of these soils have been seen that it is not possible to suggest criteria for their subdivision into series, but their limited extent and low agricultural potential suggest that it may not be necessary.

The soils appear to be largely unused. It is assumed that tinta and other timbers were extracted when the area was logged. The current logging revival in eastern Corozal District is unlikely to find much of interest in these forests except possibly some tinta.

The impeded drainage of these soils restricts their agricultural potential. If drained, their shallowness would tend to make them droughty. As can be seen in Table A2.3, the cropping systems for which the better-drained soils are assessed as moderately suitable are pasture, maize, rice, sugar cane, pineapples and vegetables.

Yaxa Suite

The Yaxa Suite includes all of the well and imperfectly drained clays over Late Cretaceous to Early Tertiary limestone that underlies most of Orange Walk District. The suite includes most of the soils of the Yaxa suites of Wright *et al.* (1959) and Birchall and Jenkin (1979). Features common to all soils in the suite are fine texture, neutral or alkaline pH, and complete base-saturation, mainly by calcium.

The soils are very extensive and support some of the largest tracts of uncleared lowland forest in the country. They also support areas of relatively intensive agricultural production, such as at Blue Creek and Gallon Jug. There are five subsuites:

(i) Yalbac — Black, dark grey or greyish brown clay. Variable depth and drainage;

(ii) Jolja — Black or grey flinty clay. Variable depth and drainage;

(iii) Chacluum — Red clay. Moderately shallow and well drained;

(iv) Ramgoat — Red over yellow clay. Moderately deep, and well- to imperfectly drained;

(v) Irishcreek — Deep mottled clay. Imperfectly drained.

Yalbac Subsuite

The Yalbac Subsuite is one of the most extensive subsuites in the country. There are large tracts of these dark clays in central and western Orange Walk District. They are also extensive south of the Yalbac Hills watershed in Cayo District (Birchall and Jenkin, 1979). It is thought these soils extend into the Western Peten of Guatemala, and into Mexico.

Large areas are still under forest, although modified to some extent by logging and chicle gathering. On most well-drained sites there are high, semi-deciduous broadleaf forests that include mahogany, cedar, sapote and patches of cohune. In low-lying areas and on some footslopes, where the drainage is imperfect, (particularly in subunit 'W') the forests are lower and contain more pucte trees, and botan palms.

There is a considerable morphological range within the subsuite. The soils vary from shallow dark clay over limestone to moderately deep mottled clays. In this the subsuite resembles the Louisville soils of the Pembroke Suite.

The shallow soils consist of a black, very dark grey or very dark greyish brown clay topsoil, which has a strong medium blocky structure, which cracks and crumbles to a fine blocky or granular structure when these soils are cultivated and the surfaces become really dry, but this latter tendency is less marked than in Louisville soils. The topsoil grades down to a slightly lighter but often still dark grey clay with less pronounced but coarser blocky structures. This horizon may contain fragments of limestone in various states of weathering, and scattered fine hard black ferrimanganiferous concretions. It overlies weathering limestones at depths of 20-50 cm. There may be an intervening stone line of harder fragments but not as often as in the Louisville soils. The underlying limestone is less weathered and at a shallower depth in the Yalbac soils, so that the contrast is less pronounced.

Shallow soils predominate in these landscapes even on gentle slopes in undulating terrain (e.g. JPL profiles, XVI, XV2, XV3); but there are patches of deeper soils. The morphology of the modal soils is similar to the shallow variants but may have thicker dark topsoils or deeper less dark and more coarsely structured subsoils, with the 'stone line' or limestone below 50 cm. Examples include Profiles OZ 16, OZ 17 and OZ 33 (see Appendix 3) and JPL profile PC1.

There are also really deep ungleyed soils in well drained but deep pockets in the limestone's weathering front. They remain very dark to considerable depths of up to a metre. The underlying slightly paler lower subsoil horizons may extend to a depth of more than 2 m (e.g. Profile OZ 15). The lower subsoils often have wedge structures with polished and striated slickenside coatings on their oblique faces (e.g. Profiles OZ 15 and OZ 34 in Appendix 3). These are the soils that show the strongest cracking when the forest is removed and the surface dried. However, most of the deeper soils are in lower slope accumulation sites with somewhat impeded drainage (subunit 'W'). The soils show distinct signs of gleying in their lower horizons with paler matrix colours (pale brown or light grey) and distinct yellowish or brownish mottles (e.g. JPL profile R1 East). These horizons may also contain crystalline gypsum, as well as black manganiferous concretions.

In the field, many of the topsoils have a silty feel, but granulometric analysis shows them to be pure clays, sometimes with extremely high clay contents (e.g. up to 86% in Profile OZ 33). Clay contents are generally fairly uniform (e.g.

Profile OZ 16), but some profiles show a slight increase in clay content with depth (e.g. Profiles OZ 15 and OZ 34). The clay minerals are mostly smectitic or vermiculitic. They show considerable shrink-swell capabilities and have cation exchange capacities of 50-80 me/100 g clay. The soils have pH values (in water) of 7.0-8.5. They are fully base-saturated, with calcium as the dominant, and magnesium the main subordinate exchangeable cation. Ca:Mg ratios are generally greater than 5, but may fall to half this value in soils with a significant dolomitic component (e.g. Profile OZ 33). Total manganese contents are high, although not necessarily associated with ferrimanganiferous concretions (e.g. Profile OZ 33).

The soils probably form *in situ* or in locally transported post-solution impurity residues from the limestone. Any tendency to leaching is instantaneously countered by limestone solution, so that the soils are likely to remain calcareous, dark and smectitic for as long as the limestone is within reach of root systems. Even deeper soils are likely to remain essentially calcimorphic as long as they receive calcareous waters by means of overland flow and throughflow from shallower soils upslope. Cracking and profile inversion seem to be limited under forest. No wide or deep cracks were seen under high forest. Some cracking occurred under the lower forest on the deeper gleyed soils in the lower slope subunit. The greatest tendency for cracking and crumbling of surface structure was seen under sorghum at Gallon Jug, but our observations were made in the short and mild dry season of 1990. Cracking and slight inversion may be more widespread and important in more intense and prolonged dry seasons.

The soils correlate fairly well with the Yaxa Subsuite of Wright *et al.* (1959) and the Yalbac Subsuite of Birchall and Jenkin (1979). Because of their wide morphological range and the uncertainty over the importance of profile inversion, their placement in the international systems is less clear. Some of the common shallow profiles are probably Rendzic Leptosols (FAO/UNESCO) or Lithic Rendolls or Eutropepts (USDA). The modal soils are probably Vertic Cambisols (FAO/UNESCO) or Vertic Rendolls, with some Eutropepts (USDA). Some of the deeper soils, both gleyed and ungleyed, are probably Vertisols (Pellieutric Vertisols in the FAO/UNESCO scheme) and Entic Pelluderts in the USDA system (see McKinzie, 1979). The Entic Subgroup designation indicates the relative immaturity of the vertisolic development, and the transported nature of the parent materials.

These soils are important for future agricultural and conservation developments in Belize. Privately commissioned soil surveys have already been undertaken (e.g. McCormack, 1987), and more are likely in the future. Subdivision into series is therefore essential. The Belize Valley semi-detailed study (Birchall and Jenkin, 1979) recognized seven series in their Yalbac Subsuite:

(i) Piedregal	Interspersed with rock outcrops. Stony throughout. Limestone at a depth of less than 40 cm and usually hard;
(ii) Chorro	Less stony surface horizons. Deeper, with hard limestone at a depth of 25-60 cm;
(iii) Tambos	Generally stone-free topsoil, with strong coarse blocky structure. Subsoil may be stony becoming weathered limestone at a depth of 40-80 cm;
(iv) Spanish Lookout	Deeper with unmottled dark clay over slightly mottled weathered limestone at a depth of 50-90 cm. There may be slickensides and gypsum in the lower subsoil;
(v) Beaver Dam	Very extensive in undulating areas. Deep and imperfectly drained with mottles below a depth of 20 cm, and slickensides and gypsum common in the lower horizons. Tends towards alkalche type bush in the less well drained areas;

(vi) Seven Mile	Deep dark clay with only faint subsoil mottling. Coarse blocky topsoils. Often has slickensides and gypsum in the subsoil;
(vii) Cadena Creek	Deep and mottled, close to creeks and swamps.

Even though their study covered only the southern part of the range of these soils in Belize, their subdivision seems more or less appropriate for the subsuite. Their series correlate reasonably well with our rough fourfold division:

(i) Shallow	Piedregal, Chorro and shallower Tambos;
(ii) Modal	Deeper Tambos and Spanish Lookout;
(iii) Deep, unmottled	Seven Mile;
(iv) Deep, mottled	Better-drained soils of the Beaver Dam and Cadena Creek series.

Beaver Dam Series soils with akalche bush and the wetter soils of the Cadena Creek series have been excluded from this subsuite and suite. They have been grouped instead with the seasonal gleys of the Chucum and Pucte subsuites in the Tintal Suite.

These soils have produced much of the country's mahogany, cedar and chicle in the past, but were not clear-felled. Some of the areas logged earlier this century are being relogged now. Agriculturally, these were important soils in Maya times, as indicated by the profusion of sites at Xunantunich, Kaxil Vinic, La Milpa and many others. These soils are still used very satisfactorily for smallholder milpa-style farming in the San Felipe-Indian Church area. There are also considerable areas of modern and more intensive farming, including cereal, pasture, coffee and cacao at Gallon Jug, pasture and sorghum cultivation at Blue Creek, and small areas at Shipyards. Around San Felipe and where small patches of these soils occur further north, in the Shipyard-Orange Walk area, the soils are used for sugar cane.

The limitations of these soils vary considerably, according to the morphological range. The shallower soils tend to be droughty in dry weather, whereas imperfect drainage and poor subsoil aeration in wet weather will affect the deep mottled profiles. The deep unmottled soils have a good combination of drainage and moisture capacity. Their main physical limitation is the possibility of rupture of young tree crop roots by cracking and swelling.

Chemically, these soils tend to be less well-endowed with phosphate and potassium than the morphologically similar Louisville soils further north. Nonetheless, they are quite fertile, and extensive agriculture will not require heavy inputs of fertilizer. Intensification will greatly increase the need for, and response to, fertilizers. Phosphate fertilizer is likely to be the most necessary, but potassium and nitrogen will also be required.

The modal and unmottled deep soils are assessed as highly suitable for cereals and pasture. This is the combination grown by Mennonite communities at Blue Creek and Shipyard, and also at Spanish Lookout outside the project area, but on similar soils. The main caveat about this farming system on these soils is the increasingly apparent threat of gully erosion. A number of active gully systems can be seen on the ground and especially from the air in the Spanish Lookout area. The gullies are extending and bifurcating upslope. The erosion should be checked; otherwise agriculture could be seriously disrupted. It may be caused by grazing in very wet weather producing compacted or poached topsoils, instead of structures becoming re-inforced during the grass phase of the cropping cycle. The provision of some kind of zero grazing facility to keep stock of these soils when they are wet and structurally vulnerable may prevent initiation of gullies. It is unlikely to ameliorate those already formed. They will need active rehabilitation.

In other instances, the gullies have been triggered by inappropriate drainage or inadvertent localized increases in overland flow, caused for example by overflowing water tanks. The soils appear to be unstable, so that minor disturbances can precipitate drastic deterioration. Care in the planning and installation of this kind of drainage is required, with emphasis on oblique diversion of excess water to grassed waterways rather than up-down slope drains with outfalls in natural and unprotected drainage lines. Attention will also need to be given to the vulnerability of these soils to subterranean erosion by throughflow and piping.

The nutrient imbalance and the problems of dry season moisture deficiency in the somewhat shallow soils, and wet season moisture excess in the deep mottled soils, downgrade our assessment of these soils for most tree crops. The results of experiments in the Gallon Jug area suggest tree crops such as coffee, and probably cacao, could be successfully grown on these soils provided they are irrigated, the land surface is shaped to facilitate runoff and there is an intelligent fertilizer programme. As can be seen in Table A2.3 the soils are highly rated for cereals and pasture, the current Mennonite cropping combination. Since these soils are likely to be important in the future of Belizean development, it is essential that the erosion and other management problems should be solved.

Jolja Subsuite

The dark flinty clays of the Jolja Subsuite are patchy, but extensive in the north-western corner of Belize in the Blue Creek and Neustadt Plain land systems. They occur in most topographic positions in the rolling hilly terrain, except for the swamps and drainage lines. Their natural vegetation is semi-deciduous broadleaf forest, some of which is high forest, extensively logged for cedar and mahogany and exploited for chicle. Other areas have lower and more stunted forests, grading towards Broken Ridge.

Morphologically, the soils are dark clays or clay loams, with some similarities in colour, depth and texture to the clays of the Yalbac Subsuite. The topsoil is black or very dark grey clay-clay loam with a moderate or strong moderate subangular blocky structure, and a slightly firm consistence, grading into a slightly lighter, but still dark grey or dark brown clay with a coarser blocky structure and firm consistence. As in the Yalbac suite many of these soils are shallow but there are deeper soils with grey subsoils and moderate red and brown mottling, which are most common on lower slopes and the margins of swamps. All of these soils are underlain by Barton Creek Formation limestones, some of which are quite hard but others are weathered to form sascab.

The distinctive feature of these soils is the presence of flints, which vary greatly in frequency and in size, with some very large examples larger than 50 cm across. They may be evenly distributed throughout the profile, but are often absent from the topsoil and upper horizons. They may be concentrated in a definite subsoil stone line (e.g. Profile OZ 66), but are often evenly spread through the lower horizons (e.g. profiles OZ 11, 12 and 50). There are also places with layers of flints at the surface.

The siliceous component in the parent material of these soils influences their chemical characteristics. They range from mildly acid to mildly alkaline (pH in water 5.5-7.5), but are more or less wholly base-saturated, with calcium as the dominant exchangeable cation. The granulometric analyses confirm that the fine earth fractions of some of these soils have high clay contents throughout (e.g. Profile OZ 11). However, others have substantial fine sand contents in their upper horizons, presumably derived from the flints.

The soils seem to have developed from the solution of the underlying flinty limestones. The absence of flints from the upper horizons of some profiles is attributed mainly to fine earth excavation and surface concentration by soil fauna, such as leaf-cutting ants (*Atta* spp.). Concentration of the flints in definite stone lines may be due to creep and wash processes. The exposure of flint layers at the surface may be due to profile truncation removing stone-free material.

The slightly acid pH and medium-textured upper horizons mean that some of these soils differ from the Yaxa Suite norm of calcareous clays. They have been grouped together with the dark calcareous clay of the Yalbac Subsuite because of their general morphological similarities, and because the distributions of the soils of the two subsuites are intricately intermixed. There are areas where Jolja and Yalbac soils alternate at intervals of tens or scores of metres.

Charter (1941) mapped the whole of the north-western part of Belize as Arenal and Soccotz suites. He mentions concretionary chert as a feature of some of the soils in his Arenal Suite. Jolja soils occupy part of the area mapped as the Jolja Set by Wright *et al.* (1959), but they make no mention of the flints in their text, although high concentrations of surface flints are indicated on their map. Despite the disparity, their description of the colours and slightly acid reactions show that their and our Jolja sets are basically the same.

In the international systems the soils fall into different categories according to their depths and stone content. The shallower and stonier soils are probably Eutric Leptosols (FAO/UNESCO) or clayey skeletal Eutropepts, whereas the deeper profiles probably qualify as Eutric Cambisols (FAO/UNESCO) or clayey skeletal Typic Rendolls. The definitive presence of flints clearly distinguishes this subsuite from others in the Yaxa Suite.

The greatest possibility of confusion is between those Jolja soils with significant sand contents in their topsoils, and some of the darker soils of the Jobo Subsuite in the Altun Ha Suite. However, the Jobo soils occur on the Northern Coastal Plain over 50 km to the east. They also overlie the younger Doubloon Bank Group limestone. The differences in environment and parent material justify separate classification.

If series subdivision is required, depth and drainage will probably be the most satisfactory criteria. As the deeper and more mottled soils occur mainly in lower-lying areas, series so defined are likely to provide satisfactory large-scale mapping units. Topsoil texture and acidity may also be useful criteria.

Most of the soils are currently under forest, although much disturbed by logging and chicle gathering. Some of the forests are now being cleared for pasture in the Bedraan Ranch and for maize/pasture rotation by the Mennonites.

The shallowness and stoniness of many of these soils mean they tend to be droughty. The stones add a further limitation as they cause wear and tear on cultivation and other implements. The slight acidity indicates slightly less fertility than the truly calcareous clays of the Yalbac Subsuite.

The combined limitations produce soils only marginally suitable for arable production. They are rated as mainly unsuitable for tree crops. As shown in Table A2.3, pasture is the only cropping system for which they are considered moderately suitable.

Chacluum Subsuite

Chacluum Subsuite soils are well-drained, shallow and moderately deep red calcareous clays, covering large areas of the undulating plain of the Hill Bank Plain land system, and on the gentler slopes of the Wamil Plain with Hills land system. They tend to be intricately intermixed with the deeper and yellower clays of the Ramgoat Subsuite. Their natural vegetation is tall semi-deciduous broadleaf forest with many cedar, mahogany, sapote, santa maria and occasional massive guanacaste. Cohune palms are quite dense and tall in places but their distribution is patchy.

The soil profile is quite simple, with a dark reddish brown clay topsoil grading into a red clay subsoil overlying limestone. The topsoil tends to have a fine blocky, granular or crumb structure. The subsoil has medium or coarse blocky structures which may have moderate shiny clay pressure faces. Consistence varies from friable in the topsoil to firm in the subsoil. The underlying limestone is often soft and weathered into sascab. As in many other limestone soils in Northern Belize, it is often capped by a fractured carapace of fragments of harder and less weathered limestone. The depth to limestone varies from 20 cm to about 70 cm. Soils deeper than this tend to have a compact, yellowish subsoil which qualifies them for the Ramgoat subsuite.

The soils are moderately alkaline (pH in water 7-8), and fully base-saturated, with calcium as the dominant exchangeable cation. Organic matter and total nitrogen contents are higher than the reddish colours indicate, which mask the darkening effect of the organic matter. The reddish colours are due to the presence of substantial free ferruginous sesquioxides, giving the soils a significant capacity to fix phosphate.

The soils probably formed *in situ* from solution residues of the underlying limestone. The moderately high content of free iron sesquioxides is probably derived from ferruginous impurities in the limestone. As in the Xaibe clays further north, contamination with volcanic ash, either during the formation of the limestone, or after its uplift and exposure, may have produced these impurities. The inclusion of both the dark Yalbac clays and the red Chacluum clays in the same suite corresponds with the inclusion of both the Louisville and Xaibe subsuites into the Pembroke Suite.

It is clear from the question marks on Charter's (1941) map that he saw little of this area. These soils may correspond with the red calcareous clays of his Soccotz Suite, but these are too cryptically characterized to permit confident correlation. The soils correspond with the Chacluum Set of Wright *et al.* (1959). This unit and name have also been used by consultant soil surveyors subsequently working in the Yalbac Ranch area (e.g. McCormack, 1987; J. Jacobs, 1990, personal communication).

In the FAO/UNESCO system most of the soils are Chromic Cambisols, although a few of the deep profiles may qualify as Chromic Luvisols. In the USDA Soil Taxonomy they appear to be either Chromic Eutropepts or, for the deeper soils, Rhodudalfs.

These soils are clearly distinguished by colour from the other subsuites in the Yaxa Suite. The soils most likely to be confused with Chacluum are the red calcareous clays of the Xaibe Subsuite in the Pembroke Suite, which are morphologically similar, but have thicker and more continuous carapace stone lines. They are also very similar chemically. The two groups of soils occur in different climates and on limestones of different ages. Their natural vegetations share many common species, but the forest on the Chacluum clays is considerably taller. For these geographical and edaphological, as much as purely pedological reasons, the two groups are kept separate for the present.

Considerable areas of these soils are currently being cleared and planted to citrus. Further development is likely with the opening of the new San Felipe-Hill Bank road and the upgrading of the Hill Bank-Gallon Jug road. It is possible that some of these developments will require fairly detailed soil surveys, and therefore the subdivision of these soils into series. Depth to, and degree of induration of, the limestone are likely to be the most useful criteria.

Most of these soils are currently under forest which has been repeatedly logged for mahogany and cedar, and which is now being relogged with far more secondary hardwood species being taken than was previously the case. Areas around Hill Bank were cleared some time ago for milpa agriculture and have mostly fallen into disuse and reverted to tall secondary wamil. Further south, soils are being cleared and planted with extensive citrus groves.

The soils are reasonably fertile, with good drainage and reasonable nutrient status. Their main limitations are a tendency to droughtiness, especially in the shallower soils, and some nutrient imbalance. Phosphate fixation will occur and deficiencies are likely to appear in intensive agriculture, such as in the large scale commercial citrus groves currently being developed. These limitations notwithstanding, they appear to be potentially productive and versatile soils, and have been assessed accordingly in Table A2.3. The only crops for which they are rated as unsuitable are cashew (because of lack of rooting depth) and cotton and rice, (mainly because of droughtiness).

Ramgoat Subsuite

The Ramgoat Subsuite consists of well-imperfectly drained red-over-yellow calcareous clays in the Yalbac Ranch-Hill Bank area. They are intimately intermixed with the red Chacluum clays. Their natural vegetation is tall semi-deciduous broadleaf forest, with common sapote, mahogany, cedar, santa maria and some large guanacaste. In many areas botan, rather than cohune, is the commonest palm.

The soils have a distinctive profile morphology. The topsoil is shallow dark brown or dark reddish brown clay, with strong fine subangular blocky structures and firm consistence, overlying a red or reddish brown clay, with moderate medium blocky structure, and which may contain ferrimanganiferous concentrations, some as soft black stains and some indurated as black-dark brown concretions. This horizon has a fragic consistence in that it is hard and compact *in situ* but crumbles easily in the hand when displaced.

It grades into a bright yellow-reddish yellow clay with many black ferrimanganiferous stains and concretions. The structures and consistence are similar to the overlying red clay, except for the presence of stronger shiny clay coatings or pressure faces and greater fragic propensity, with intense compaction whilst in place. The intense compaction makes augering and digging very difficult, but the trees of the natural forest seem able to root freely into these horizons. The compaction may only occur in the dry season and the horizons may be relatively friable once they are thoroughly moistened in the wet season. The frequency of the ferrimanganiferous concretions increases with depth until the hard limestone is reached. The soils are fairly deep with the limestone often below a depth of 1 m. They are weathered to sascab, but not to great depth, and often have a marked capping of harder rock fragments.

Two profiles were analysed (profile OZ 47 and OZ 67). The results indicate the soils are neutral-mildly alkaline and fully base-saturated, with calcium as the dominant exchangeable cation. Organic matter contents are higher than the red and yellow colours, derived from the free ferruginous sesquioxides, suggest. Phosphate contents are moderate but fixation of this nutrient by the sesquioxides is likely.

The genesis of these soils is uncertain. They are probably derived from the solution residues of the weathered limestone. The red-over-yellow colour sequence and the number of ferrimanganiferous concretions suggest the lower horizons are imperfectly drained, but their current topographic position and the natural vegetation give few indications of this. Alternatively, the red over yellow sequence may be due to slopewash: the upper red clay may be derived from a more ferruginous limestone than the underlying yellowish clay. The subdued terrain and lack of stone lines or other profile features do not support this alternative explanation.

As can be seen in Table A2.2, the soils correspond with the Ramgoat clays of Wright *et al.* (1959). Charter makes no mention of yellowish subsoils in his very brief outline of the Soccotz Suite – the soil he tentatively mapped for this area.

In the international schemes the soils may show enough increase in clay content with depth to be classed as Chromic or Ferric Luvisols (FAO/UNESCO) or Rhodudalfs (USDA). Where clay increases are insufficient, they qualify only for the less developed groups of Ferric Chromic Cambisols (FAO/UNESCO) or Chromic Eutropepts (USDA).

The soils are quite distinctive and relatively easy to recognize from other groups. They grade into the red clays of the Chacluum Subsuite, with an intergrade in which an incipient yellowish lower subsoil is apparent.

The soils will probably be cleared and developed, now that access is greatly improved by the opening of the San Felipe-Hill Bank road. If detailed soil surveys should be undertaken, and this subsuite needs subdivision into series, the depth to limestone and degree of subsoil compaction are likely to be most satisfactory criteria.

The soils are mostly under forest that has been logged for mahogany and cedar several times in the past century or so. There is a current revival in logging with many more secondary hardwood species taken. These soils will probably be developed for large-scale agriculture in the near future. Some areas are already being cleared for large scale commercial citrus on Yalbac Ranch.

The suspect drainage, subsoil compaction and possible nutrient imbalances are the main limitations of these soils for agriculture. The drainage and compaction will both require investigation if these soils are to be intensively exploited on a large scale. Is the drainage as free as the vegetation suggests or is it impeded, as indicated by the yellowish colours in the lower subsoil? Is the subsoil compaction seen in the dry season a permanent or seasonal feature? To what extent does it inhibit root penetration and function?

Phosphate fixation and deficiency problems are likely. The doubts over the edaphological characteristics of these soils are reflected in the varying assessments in Table A2.3. Citrus, robusta coffee, vegetables and pineapples are reckoned to be the crops most suited to these soils. However, it must be reiterated that little is known about these soils and their potential.

Irish Creek Subsuite

The deep mottled clays of the Irish Creek Subsuite occur close to drainage lines and swamps in the Hill Bank area (lower slope subunit). They are common along the eastern stretches of the Hill Bank-Gallon Jug road. They are the imperfectly drained lower slope analogues of the red and yellow clays of the Chacluum and Ramgoat subsuites. Their natural vegetation is low-moderate semi-deciduous broadleaf forest. It has a high proportion of swamp margin species, especially pucte. Botan is the main palm, with little or no cohune.

The dominant feature of the morphology of these soils is the grey and reddish mottled clay subsoil. The topsoils are brown, have a moderate crumb structure and are quite friable. In most soils it is a clay, but in Profile OZ 69 there is some fine sand admixed. The topsoil grades down into a deep light grey mottled clay. The mottles are reddish yellow or red through most of the solum, but become yellower towards the base, near the limestone. The light grey and red mottling is distinct but does not achieve the striking contrasts found in the 'corned beef' mottled subsoils of the Puletan suite. The lower subsoil contains black ferrimanganiferous concentrations, both as soft stains and hard concretions, which become abundant close to the limestone. They may also contain gypsum crystals. Because of the depth of soil, the limestone could not be examined in detail but it appears to be only slightly weathered (e.g. Profile OZ 69).

Laboratory analyses indicate moderate alkalinity and full base saturation. Calcium is the dominant exchangeable cation. Organic matter, nitrogen and phosphate contents are moderate. The granulometric analyses confirm the field textures and the presence of substantial fine sand and silt in the upper horizons of Profile OZ 69. The analyses of samples 69/3 and 69/4 from profile OZ 69 (Appendix 3) indicate some clay movement, and that the shiny coatings on subsoil structure faces may not be wholly due to swelling pressures.

The soils are thought to have formed in slopewash material derived from the sedentary calcareous clays upslope. The grey matrix colours in the subsoil indicate drainage is impeded for much of the year, although Profile OZ 69 was no more than moist to over 2 m when seen during the dry season.

The taxonomic status of these soils is somewhat inconsistent. In some of the dark calcareous clays e.g. Yalbac in Yaxa suite, and Louisville and Concepcion in Pembroke Suite, the deep mottled lower slope profiles are seen as variants within the subsuites. For the red clays, the morphological change is so much greater that the deep, paler coloured, mottled slopewash soils of lowlying areas are given separate subsuite status i.e. Irish Creek here and Puluacax in Pembroke Suite. Wright *et al.* (1959) did not make this separation in the case of the soils of the Irish Creek Subsuite (although they did separate Puluacax from Xaibe). Their nearest equivalent to Irish Creek are the mottled clay variants (10c and 11c) of the Ramgoat and Chacluum clays. Irish Creek probably also includes some of the soils of their Pucte Set. In the Belize Valley survey, the nearest equivalent is Tillet and Potts Series in their Chacluum Subsuite (Birchall and Jenkin, 1979).

In the international systems the soil drainage is probably sufficiently impeded to designate these soils Eutric Gleysols (FAO/UNESCO) or Eutric Tropaquepts (USDA).

Distinction of these soils from some other groups is not always clear. The deep mottled variant of Yalbac is somewhat similar, but its mottling is less distinct and rarely includes red colours. The Irish Creek Subsuite grades into the Pucte Subsuite in Tintal Suite, but the Pucte soils are more definitely gleyed with paler and less distinct mottles. They are also wetter, with only the top 30-80 cm drying out at all, even towards the end of the dry season. At 1 m depth they remain saturated throughout the year, in contrast to Irish Creek soils which partially dry out to a depth of more than 2 m. The drier Irish Creek soils presumably grade through to the yellow clays of the Ramgoat Subsuite, but no intergrades or problematic identifications were actually seen during the survey.

The soils are not extensive, nor do they have very high agricultural potential; so detailed surveys or subdivision into series will probably not be needed. If series subdivision is required, the most useful criteria are drainage status and the presence/absence of coarser-textured surface layers.

The soils are little used, and the forests have yielded few merchantable logs, because of their low stature. Poor drainage reduces their agricultural potential, but since they occur along some moderately well-defined and incised drainage lines, such as Irish Creek itself, there are potential outfalls, and the soils may be drainable. It is notable that the banks of the Irish Creek were one of the areas where the ancient Maya controlled soil hydrology by means of a complex of channelled raised fields (Ford and Fedick, 1988). Most assessments are therefore N1w – currently unsuitable due to poor drainage (but possibly remediable) – in Table A2.3. Rice is probably the most suitable crop in the undrained soils, but will need fertilization if it is grown intensively.

CHACALTE SUITE

Chacalte Suite clays are formed on the Cretaceous limestone to the south of the Belize valley. They occupy the Central Foothills and large areas in the Western Uplands land regions. The soils are all fine-textured and mostly dark-coloured, with black and dark grey predominant. There are also some clays with reddish subsoils. The climate is somewhat wetter than further north, so that these soils are slightly more leached. Soil reaction may be up to a unit lower and be neutral rather than mildly alkaline. Many of these soils are highly (about 70-80%) rather than totally, base-saturated. There are three subsuites:

- (i) Cabro — Shallow (less than about 25 cm) dark clays;
- (ii) Xpicilha — Moderate depth (25 to about 70-80 cm) clays. Mostly dark but some reddish soils;

(iii) San Lucas	Deep (more than 70 cm) colluvial clays of lower slopes and basin flats. Mostly dark grey-grey; may be mottled in lower subsoil.

This subdivision of the clays over Cretaceous limestone is the same as that used in the Toledo and Stann Creek surveys (King *et al.*, 1986; 1989). It is different from that used for the clays over the younger limestones further north. In the Chacalte Suite, the subsuites are defined in terms of depth, and allowed to vary in colour. In Pembroke and Yaxa Suites the subsuites are defined on colour, and encompass considerable internal variation in depth. This anomaly will need correcting when rationalizing and formalizing a national soil classification.

Cabro Subsuite

The soils of the Cabro Subsuite are the most frequent on steep slopes in the Cretaceous limestone karst terrain in the south of the project area. They occupy large areas in the Central Foothills and Western Uplands land regions. Their natural vegetation is semi-deciduous broadleaf forest, patches of which have a high proportion of quamwood as evidenced by the mass of yellow flowering crowns in the middle of the dry season. Some of these forests also contain high proportions of cohune palms; and scattered moho and cortez trees.

The soils occur on steep and rocky land. Detached boulders and in situ outcrops of hard limestone are scattered on the soil surface. The intervening profiles are simple and shallow, with a black or very dark grey clay, which is often stony, grading into hard limestone at a depth of about 30 cm or less. There may be some brownish and reddish colours in the lower part of the clay. The structure usually grades from fine to medium blocky, but there are some crumb-structured topsoils. Permeability is high and drainage rapid.

Leaching is countered by the proximity of limestone. The soils are neutral or mildly alkaline, and usually fully base-saturated, with calcium as the dominant cation. The granulometric analyses may indicate substantial sand contents due to finely comminuted limestone.

The soils form by the solution weathering of the underlying limestone. Despite the high infiltration capacity and rapid drainage, the soils appear to be subject to profile truncation by surface wash or various creep processes, which keep the profiles perpetually shallow and stony, and provide the parent materials for the deeper soils downslope.

The separation of these soils on depth is somewhat anomalous, as noted in the discussion of the suite above but it permits a degree of correlation with previous surveys. Earlier workers tended to subdivide these shallow soils by colour or according to environmental conditions of the soils downslope. They correspond to the La Flore (black and dark grey) and Gracie Rock (reddish) suites of Charter (1941). They also appear to correspond to some of the shallower soils in his Mountain Cow series. Wright *et al.*, (1959) also distinguished a number of subdivisions of these soils. The stony chacalte sets (17H and 17cH), and their analogues in cooler and wetter climates in the Cumbre set (19H and 19aH) correspond to those on moderate slopes, whereas the really stony soils on steep slopes correspond to their Dry Creek (reddish) and Cabro (dark) sets.

In the international systems their classification is relatively straightforward as Rendzic Leptosols (FAO/UNESLO) and Lithic or possibly Rendollic Eutropepts (USDA).

The soils look very similar to some of the shallower and more stony soils in Yaxa, Cuxu and Pembroke Suites, but they tend to be slightly more leached and less base-saturated. The real difference, however, is geographical and environmental, as these soils are separated on grounds of climate, forest composition and age of parent material.

In Toledo District (King *et al.*, 1986) these soils were subdivided into Canop and Hokeb Series on whether the depth to hard rock was more or less than

10 cm. An alternative criterion could be the frequency of surface rocks, as this can affect silvicultural operations.

Most of the soils are under forest. Those in the Chiquibul area have been logged for mahogany and cedar, but the density of large stems and the degree of disturbance was probably not high. A recent worrying trend in the use of these soils has been their exploitation for milpa agriculture, and as a source of rock for lime burning by the new communities along the Hummingbird Highway (Day *et al.*, 1987b). Despite their good structures and high permeability, the soils are erodible, and there is some evidence that even a few years of milpa causes a significant loss of soil and decrease in solum depth (Furley, 1987). This may produce sufficient changes in soil conditions to deflect the natural forest succession, possibly leading to a prolonged scrubby phase. However, a protective cover of vegetation of some sort seems to be rapidly re-established when cropping is complete. The effects of the excavation of lime for burning are localized but severe, with forest and soil completely stripped, and gashes of bare rock appearing. Unlike the milpa areas, it is unlikely that these areas will revegetate rapidly and thickly enough to protect the soil from further erosion. The scars may be self-regenerating and become permanent and growing features in the landscape.

The vulnerability to erosion disqualifies these soils from large-scale agricultural development, although incorporation of small areas to round off blocks may be necessary. Sustainable development for smallholder tree crops on the gentler slopes may be possible without damage to the soils and threat to the long-term viability of the enterprise. Small areas of these soils have been so developed for cacao in the Ringtail Village development. However, although the soil is not being eroded, the cacao does not appear to be thriving. The shallowness and stoniness and the generally free drainage through the underlying limestone tends to make these soils droughty. Tree crops therefore need very gentle handling, particularly in the management of shade in their early stages, but mature crops may be able to exploit some of the moisture in the porous, fractured limestone, in a fashion similar to the natural forest.

In general, though, it is recommended that these soils should be left under natural forest as environmental protection, and not timber production.

Xpicilha Subsuite

The soils of the Xpicilha Subsuite are moderately deep calcareous clays over Cretaceous limestone. They are widespread in the Central Foothills and Western Upland land region. They occur on gentler gradients than the Cabro soils, often on colluvial lower slopes of tower and cone karst hills. Their natural vegetation is semi-deciduous broadleaf forest, similar in composition to that on the shallower Cabro soils, but possibly taller. There are scattered occurrences of surface stones and rocks. The topsoil is mostly black or very dark grey slightly friable clay, with a fine subangular blocky or medium crumb or granular structure, overlying a dark grey, dark brown or reddish brown clay, which is firm and has a moderate medium blockly structure. The subsoil peds have shiny clay coatings most of which are probably pressure faces. The subsoils may overlie weathering limestone directly or there may be an intervening horizon of olive yellow-grey massive clay, often with many black ferrimanganiferous stains and concretions. This horizon may be quite discontinuous, occurring only in pockets in the weathering surface of the limestone. The limestone tends to be fairly hard, and the 'carapace over sascab' pattern characteristic of the dark calcareous clays in northern Belize, is not widespread beneath the soils of Xpicilha Subsuite.

The soils are moderately leached but are rarely more acid than pH 6 (in water) or have base saturations less than about 70%. The granulometric analyses give clay contents of 65% and over. There may be a slight increase in clay content with depth, but some profiles are texturally quite uniform with depth.

The soils are thought to derive partly from solution residues from the underlying limestone, and partly from wash and creep material from the shallow and assumedly truncating Cabro soils upslope. The patchy olive yellow-grey clays with ferrimanganiferous concentrations of the lower subsoil are attributed to localized impeded drainage, particularly in pockets in the weathering front over limestone that is not jointed or fractured.

The main classification query in these soils is that common to the whole suite, i.e. the inclusion of black and red clays in the same subsuite, whereas they have been separated at subsuite level in the calcareous clays on younger limestones to the north. This is an anomaly that needs to be sorted out when the national soil classification is consolidated and rationalized.

The soils correlate with the deeper soils in Gracie Rock and La Flore suites of Charter (1941) and the non-hilly Chacalte, Xpicilha and Cumbre sets of Wright *et al.* (1959). The definition of these soils has not changed since the surveys of Toledo and Stann Creek districts (King *et al.*, 1986, 1989).

In the international systems the soils probably fall into higher taxa indicating only moderate pedogenetic development, i.e. Cambisols in the FAO/UNESCO system and Inceptisols in the USDA system. The main problem is the subunit/suborder or great group qualifier. In some of them there may be enough clay cracking and subsoil pedoturbation for the soils to qualify as Vertic Cambisols (FAO/UNESCO) or Vertic Eutropepts (USDA). In others, the dark clay-humus-calcium derived surface colours are the dominant features, in which case the soils are Humic Eutric Cambisols (FAO/UNESCO) or Rendollic Eutropepts (USDA). A few of the deeper soils may be slightly Eutric Pelludertic Rendolls in the USDA system.

The soils are clearly distinguished from the others in the suite by depth and degree of horizonation. They may appear to be somewhat similar to the modal and slightly deeper clays in Yalbac, Chacluum, Louisville, Concepcion and Xaibe suites, but they usually lack the hard carapace over soft sascab that underlies these other soils to a greater or lesser extent. They are also more leached, more likely to be slightly acid and less than totally base-saturated. The main differences, though, are age of parent limestone, location and environment.

The soils were subdivided into series in Toledo District (King *et al.*, 1986). The main criterion was subsoil colour, with Quam, Corazon and Roaring Creek distinguished by their dark, reddish and olive-yellowish subsoils respectively. The olive yellow colours probably indicate slightly impeded drainage, whereas the dark/red division is mainly attributed to the degree of ferruginous impurities in the limestone. Another useful criterion for subdivision, although not necessarily at series level, is the frequency of surface stones and rocks, as this can considerably affect soil management.

There are large areas of these soils in the Chiquibul Forest Reserve that are still forested. They have mostly been quite heavily logged in the past, because their location on the lower slopes and inter-karstic plains makes them quite accessible in the dry season.

The soils are used for milpa agriculture by the settlers in the new communities along the Hummingbird Highway. They also occur in the cacao developments at Ringtail Village, and in patches on eastern parts of the Hummingbird Highway, around Over-the-Top, where new citrus developments encroach slightly onto these soils.

Although deeper than the Cabro Subsuite, these soils are still considered somewhat droughty. They are therefore downrated for sensitive crops such as cacao, soya and rice. For more drought-hardy crops such as citrus and sorghum, nutrient imbalances are likely to be the substantial limitations. The soils are rated as only marginally suitable at best, except possibly for milpa. Although the erosion hazard is less than on the neighbouring steep slopes with Cabro soils, there is still an erosion risk and agricultural development should be monitored.

The soils share many of the physical attributes of the calcareous clays at Spanish Lookout, where there is some gullying.

San Lucas Subsuite

The soils of the San Lucas Subsuite are the deepest in the Chacalte Suite. They occur on the undulating and rolling plains of the Western Uplands; and on footslopes in the Central Foothills. Their natural vegetation varies from semi-deciduous broadleaf forest, which is similar in composition to that on the soils of the Cabro and Xpicilha Subsuites upslope (but possibly taller, and rather more structured), to rather lower swamp margin forest, with pucte trees and botan palms.

The profile is deep and often shows signs of impeded drainage. The topsoil is usually black or very dark grey clay with a fine block or medium crumb/granular structure and slightly friable consistence. It grades into a grey clay subsoil, which has a medium blocky structure, becoming coarser with depth and may even become wedged with oblique surfaces. Ped surfaces often have shiny coatings, mostly attributed to pressure faces. Some of those on the oblique ped faces are sufficiently striated to qualify as slickensides (e.g. profile OZ 76 in Appendix 3). The lower subsoils tend to become lighter in colour until the matrix is light grey, usually with reddish, brownish or yellowish faint – or possibly distinct but never prominent – mottles. The lighter coloured mottled clay of the lower subsoil often contains hard round black ferrimanganiferous concretions. The underlying limestone is usually encountered at a depth of 1-2 m, but may be deeper (e.g. profile OZ 76).

The soils have an approximately neutral reaction, and are not wholly base-saturated. They have high clay contents throughout; but there may be some random fluctuations in clay content with depth, probably reflecting the vagaries of colluvial accretion.

The parent material of these soils is mostly hillwash. An indication of the hillwash origin can be seen in what appears to be a recent deposit (at a depth of 0-4 cm) over a buried topsoil (at a depth of 4-22 cm) in profile OZ 76. Similar apparent discontinuities occur elsewhere. The light grey colours, mottles and ferrimanganiferous concretions indicate that pedogenesis in the lower horizons takes place in intermittently anaerobic conditions.

As already noted, the separation of these soils at subsuite level is somewhat anomalous. Their equivalents in Yaxa and Pembroke Suites are induced with shallower and better drained dark clays as deep variants within the Yaxa and Pembroke Suites.

Their correlation with earlier soil classifications is quite complicated, as can be seen in Table A2.2. As these soils are not gravelly, the correspondence with the Hiccattee Set (Wright *et al.*, 1959) is tenuous.

In the international systems, most of the soils have sufficient slickensides to qualify as Vertisols although really wide and deep cracks are rarely seen under undisturbed forest. In the FAO/UNESCO system they are Eutric Vertisols, whereas in the Soil Taxonomy they are Pelluderts, probably Eutropeptic. Where there are insufficent cracks and slickensides for Vertisols, soils are Vertic or Eutric (occasionally Gleyic) Cambisols in the FAO/UNESCO system and Pelludertic Eutropepts (USDA).

These soils are relatively easily distinguished from the shallower subsuites in the Chacalte Suite. They are morphologically somewhat similar to the deep mottled clays in Yalbac and Louisville subsuites, but are more leached, less alkaline and less fully base-saturated. The real difference is the geological age of the parent limestone, and the different climate and environment due to the more southerly location.

King *et al.* (1986) subdivided these soils in Toledo district into series on the presence/absence of a reddish or brownish horizon in the upper subsoil. This is a useful criterion, and could be extended by making further distinctions in the wholly grey soils according to the depth of mottling and wetness.

Although the soils are mostly under forest, they are the most commonly cultivated in the Chacalte Suite because of their relatively easy access. Some of these soils at Ringtail Village are under cacao. Small patches may also be inadvertently included in citrus development in the Over-the-Top area. The forest here has been rather more heavily logged than the forest on the steep hillsides.

The impeded drainage is the main limitation on crop growth, as indicated by the preponderance of 'w' subscripts in the suitability assessment in Table A2.3. The most suitable crops are those tolerant of occasionally and slightly anaerobic conditions, and a cation balance dominated by calcium. Pasture, sugar cane, some dry season vegetables and maize/sorghum are moderately suitable on the better-drained soils and rice on the wetter soils. For many of the arable crops, workability and access during wet spells may be limitations which reduce the versatility of these soils.

Vaca Suite

The Vaca Suite includes the brown and reddish brown calcareous clays over cretaceous limestone in the Central Foothills and Western Uplands.

The separation of these soils at suite level is debatable. They may be the more ferruginous equivalents of Cabro and Xpicilha subsuites. They could then be incorporated into Chacalte Suite as a reddish subsuite: analogues of Xaibe Subsuite in Pembroke Suite and Chacluum Subsuite in the Yaxa Suite on the younger limestones further north. The taxonomic status of these soils needs resolving when the national soil classification is consolidated and rationalized.

The reason for their present status is their geographical location. They are mainly located at low-intermediate altitudes in the Central Foothills, and are particularly prominent on the limestone hills on the southern side of the Belize Valley (Birchall and Jenkin, 1979) (land systems TX and CX). They also appear to be particularly associated with the shattered limestones along the complex of faults on the northern boundary of the Maya Mountains. There is only one subsuite: Cuxu.

Cuxu Subsuite

In the project area, the generally shallow brown and reddish brown Cuxu Subsuite soils occur mostly in the Vaca Hills, in the northern part of the Western Uplands and at the western end of the Central Foothills. This is an area of fairly uniform soil cover, with patches of deep mottled dark clays of the San Lucas Subsuite in basins and drainage lines as the only substantial non-Cuxu soils over considerable areas between Spanish Waterhole and Arenal.

These soils occur in all parts of the rugged cone karst (almost cockpit) landscape, apart from some low-lying areas. The natural vegetation is semi-deciduous broadleaf forest of moderate stature. They include many sapote, cohune, and, formerly, mahogany and cedar.

The topsoil is (very) dark brown clay with a fine blocky or medium crumb/granular structure overlying dark brown, brown or reddish brown clay with medium or coarse blocky structures, which often have shiny coatings attributed mainly to pressure faces rather than the illuvial clay. This lower horizon may well contain limestone fragments. It overlies hard limestone, usually fractured into a stone or boulder layer, which often occurs at 25-50 cm depth. There may be softer weathering limestone (sascab) underneath, but this is usually shallow and contains modules of harder limestone, which increase in frequency with depth until the material is predominantly hard by about 80 cm. Although mostly shallow, there are some deeper profiles, in which the colours are brighter in the lower subsoil, often yellowish or plain red (see profile OZ 37).

The soils are neutral or mildly alkaline throughout. Base saturation is close to 100%, with calcium as the dominant exchangeable cation. Organic carbon and total nitrogen contents are higher than that indicated by the reddish colours, which are due to the presence of free ferruginous sesquioxides. These sesquioxides have some capacity to fix phosphate, so that there may be phosphate deficiencies, even though there are moderate levels of available and total phosphate indicated by the analytical results. The granulometric data confirms that the fine earth fraction is mainly clay, with contents often in excess of 70%. There is little systematic increase in clay with depth, confirming clay illuviation is probably not important.

The soils are formed from the solution residues of the limestone. The reddish colours indicate ferruginous impurities in the limestone, the nature and origin of which are unknown, but they may be derived from volcanic ash inputs at the time of soil formation. The shallower soils on steep slopes are probably being eroded, causing profile truncation, as with the darker soils of the Cabro Subsuite.

At the same time, some of the deeper lower slope soils are forming an actively accreting hillwash.

As noted above, the taxonomic isolation of this subsuite in its own suite is somewhat anomalous. The possible incorporation of the Cuxu Subsuite into Chacalte Subsuite needs to be considered when the national soil classification is consolidated.

There is no clear single equivalent to this subsuite in Charter (1941). His Soccote Suite consists of red clays, but they are not described as shallow or strong and overlie unconsolidated marl rather than hard limestone. The shallower Cuxu soils are close to his Gracie Rock Suite, and some of the deeper soils may correspond to his Narango Series. The Cuxu clays are the main equivalent in Wright *et al.* (1959). There is also some correlation with the redder soils in the Hummingbird clays and, with some of the Tziminkax clays. The shallower soils correspond with the redder varieties of their Xunantunich clays.

The Belize River Valley survey mapped considerable areas of Cuxu Subsuite soils. As their project area was restricted to the lower and gentler slopes of the limestone hills adjacent to the Belize valley, they found a substantial proportion of deeper soils. Some of these are deep and red (e.g. Camelote Series), but some are mottled and have impeded drainage, e.g. Society Hall and Sayab Camp series. However, the shallow and stony Mount Hope Series is still the most extensive series. Their Cuxu Subsuite is incorporated into their Yaxa Suite, because they have only one suite for all limestone soils; and do not distinguish at suite level between soils on Cretaceous limestones to the south of the Belize Valley and those on the younger rocks to the north.

In international terms, the shallower of these soils are mostly Chromic Cambisols, with some Mollic and Lithic Leptosols (FAO/UNESCO), and Lithic or Rendollic Eutropepts (USDA). The deeper soils may qualify as Vertic Cambisols (FAO/UNESCO) or Chromudertic Eutropepts (USDA). In contrast to McKinzie (1979), we found that few of these soils qualified as Vertisols.

The distinction between these soils and those of the Chacalte Suite is mainly on colour, but the boundary between them is gradational, and there are some dark brown soils which are clearly intergrades. The soils of the Cuxu Subsuite are morphologically somewhat similar to those of Chacluum and Xaibe suites, though rather more leached and acid, and less base-saturated; but the main difference is geographical, with the Cuxu soils on older limestones and in a wetter climate.

The Belize River Valley survey (Birchall and Jenkin, 1979) separated their Cuxu Subsuite into series on the basis of depth, stone content, colour and drainage. The series are:

(i) Mount Hope — Shallow and strong, with limestone at 30-60 cm, predominantly brown. Well-drained;

(ii)	Camelote	Moderate depth and stone content, with limestone at a depth of 50-70 cm, predominantly reddish subsoils. Well-drained;
(iii)	Society Hall	Similar depths and stone content to Camelote, but colours tend to be browner, with some greys. Black manganiferous concretions in some lower subsoils. Intermittently impeded drainage;
(iv)	Sayab Camp	Deep grey clay with reddish mottles and black manganiferous concretions. Imperfectly drained.

This is a similar subdivision to that in their Yalbac Subsuite, and appears appropriate. It may be necessary to subdivide the Mount Hope series further because it is so extensive, and because it will be useful to separate the unusable very shallow and stony soils with many rocks at the surface on very steep slopes.

The Ancient Maya appear to have used the Cuxu soils extensively. The Western Uplands appear to have been densely settled, with major centres at Caracol and Xunatunich; and many others between. The soils were terraced, with lines and low walls of stones on slopes and across minor drainage lines (e.g. profile OZ 81 in Appendix 3) still extant. Whether these artefacts were primarily to retain moisture, silt or to enhance soil drainage, or were merely the result of stone-clearing is debatable. Most of the soils in the Western Uplands are under forest, which has been logged for mahogany and cedar, and exploited for chicle. Wild yams are now being collected for sale to pharmaceutical companies.

At the turn of the century, there was an apparently successful coffee plantation in the vicinity of Negroman for about 20 years. The reasons for it closure are not known. At a later date many Indian refugee farmers entered the area under the Location Ticket system and established milpa and pasture smallholdings. Many of them have since left because of water shortage and the droughtiness of the soils, but there are still extensive areas of milpa in the northern parts of the Vaca Hills (see Map 2d), mainly planted by farmers living in villages just outside the project area, such as Arenal. Medium- and large-scale commercial farmers are now rehabilitating and extending the pastures, some of which are on very steep slopes (in excess of 35° in some examples seen). So far there are no obvious signs of erosion, but they need to be carefully monitored, especially in the light of the gullying noted on limestone clays on much gentler slopes at Spanish Lookout. The deeper Cuxu soils on the gentler slopes adjacent to the Belize River Valley, outside the project area, are largely used for pastures, some cereals, either as milpa or in rotation with grass, and increasingly citrus.

The main agricultural limitation of the shallower of these soils is droughtiness. There are also problems of workability for arable crops because of the surface rocks and high stone contents. The deeper soils have better supplies of available moisture so that nutrient imbalance, due to the calcarous parent material and phosphate fixation by the free sesquioxides, may be as much of a constraint as water. As can be seen in Table A2.3, pasture is the only cropping system assessed as being moderately suitable. Current developments therefore seem appropriate, with the proviso that slopes steeper than 15° should be left under protective forest, and that all pastures should be monitored and managed to avoid the initiation of accelerated erosion, whether as sheetwash or gullies.

GUINEA GRASS SUITE

The Guinea Grass Suite contains dark calcareous soils with significant contents of quartzose sand. They occur mainly in the northern parts of Orange Walk District, with small areas in Corozal District. They are particularly concentrated on the very slight broad ridge that runs northwards from the Shipyard area between the troughs of the Hondo and New rivers to the Orange Walk/Corozal district boundary (Layaro Plain land system).

The quartzose sand is concentrated close to the soil surface, and clay contents increase with depth. The underlying parent material is limestone. The source of the sand is uncertain. It may come from arenaceous impurities in the limestone. Alternatively, it may be the remnants of a much later siliceous cover over the limestone. Such material could be of marine origin and been left on top of the limestone as it emerged from the sea. Another possibility is that it derives from old fluvial alluvium, laid down when rivers draining the northern parts of the Maya Mountains flowed northwards to Chetumal Bay rather than eastwards like the modern Belize and Siburn rivers (see Geology section). There are two subsuites:

(i) Lazaro Dark, with sandy clay loam to sandy clay topsoils;

(ii) Pixoy Dark over grey, with loamy sand or sandy loam topsoils.

Lazaro Subsuite

Lazaro Subsuite contains dark medium textured calcareous soils, which are very extensive in the Lazaro Plain land system. They occur in a range of topographic positions from broad crests to gentle lower slopes down to swamp margins. They have been almost totally cleared and developed for agriculture, mainly for pasture, sorghum and especially sugar cane. Bush remnants and reports indicate that the natural vegetation is tall semi-deciduous broadleaf forest, often with high densities of cohune palms. The forests on the lower slopes were probably of lower stature and contained more pucte trees and botan palms.

Morphologically, the soils range from quite shallow well-drained profiles (e.g. profiles OZ 23 and OZ 29 in Appendix 3), through modal well-drained soils to deeper soils (mostly of subunit 'w') in which the drainage of lower horizons is impeded.

In the shallower soils, a black or dark grey topsoil overlies a grey subsoil, which in turn overlies soft weathering limestone (sascab). The topsoil is usually sandy clay loam or occasionally sandy loam or sandy clay. The sand is predominantly fine- or very fine-grained, but the organic matter makes the soil feel siltier: several topsoils were hand-textured as silty clays or silty clay loams in the field. The topsoil structure is fine subangular blocky, often compound, breaking to a crumb. Consistence is usually friable. The grey subsoil is usually fine sandy clay with a moderate subangular blocky structure. The peds often have patchy shiny coatings, which appear to be clayskins of illuvial origin. The consistence is firm.

The boundary to the underlying limestone is generally clear. The limestone is usually soft and weathered to sascab. It is pale in colour, ranging from white through pale yellow to very pale brown. Lapping layers of harder fragments – the 'carapace' – are less common than under the dark calcarous clays of the Louisville or Yalbac subsuites.

In the modal well-drained soils, the upper horizons are very similar. There may be a horizon of grey clay, often with weaker and more massive structures, and more plastic consistence than the dark grey clay above. This horizon may also contain fragments of limestone, usually well-weathered and soft. It overlies pale coloured soft sascab at a depth of about 40-80 cm, again usually without a capping carapace of hard fragments.

The mottled soils of the lower slopes are similar but may be as deep as 2 m, and the lower grey subsoil has distinct yellowish or brownish mottles. The lower horizons tend to remain wet for considerable periods into the dry season.

Lazaro Subsuite soils are of about neutral or slightly acid reaction, especially the upper horizons of the deeper and more developed profiles. Some of these horizons appear to be non-calcareous in the field, with no discernible reaction to 2M hydrochloric acid. Nonetheless, the soils are more or less fully base-saturated, calcium being the main exchangeable cation. The granulometric analyses confirm the medium textures and high contents of fine and very fine sand. They also show that some, but not all, of the soils have substantial increases in clay content with depth, partially corroborating the argilluvial origin of the subsoil ped coatings.

Argilluviation is seen as an important process in the formation of these soils, but it must be recognized that the textural contrast in these profiles may also be partly due to inherent differences in the bisequent parent materials if they consist of coarse-grained siliceous marine or fluvial deposits overlying limestone. The combination of neutrality or mild acidity with full base saturation may reflect the balance between leaching and root uptake calcium from the relatively shallow limestone, which is recycled through litterfall.

The grouping of these soils with those of the Pixoy Subsuite, and their separation at suite level from the adjacent dark calcareous clays of the Louisville or Yalbac subsuites follows the classification structure of Wright *et al.* (1959). The Lazaro Subsuite of this study corresponds closely with Wright *et al.*'s Lazaro Sets. Charter (1941) grouped his San Pablo Series, which is the closest equivalent to the better-drained Lazaro soils, with the dark calcareous clays of his Louisville Suite. The imperfectly drained soils correspond roughly with his Orange Walk Series in his Turner Suite.

In the international systems, the shallow soils are defined in terms of their assumed limited development as Eutric Cambisols (FAO/UNESCO) or Typic Eutropepts (USDA). The designation of the deeper soils depends on the existence and pedogenetic interpretation of the textural contrast. If sufficiently sharp and of illuvial origin, the soils qualify as Haplic or possibly slightly Gleyic Luvisols (FAO/UNESCO) and Hapludalfs (USDA). Otherwise, they probably remain as deep versions of Eutric Cambisols or Eutropepts.

The finer-textured of these soils intergrade with the clays of the Louisville Subsuite, but the presence of any clearly field-discernible non-clay fine earth to a depth of more than 25 cm qualifies a soil as belonging to the Lazaro Subsuite. The gradation at the other end of the textural scale is towards the Pixoy Subsuite. The distinction is made on topsoil texture. If sandy loam or coarser textures persist below about 25 cm, the soil qualifies for the Pixoy Subsuite. Finer textures qualify a soil as belonging to the Lazaro Subsuite. Note that this definition allows the soils of the Lazaro Subsuite to have sandy loam topsoil textures, provided they are shallower than 25 cm. The only other soils that are rather similar to the Lazaro Subsuite are those of the Jobo Subsuite in the Altun Ha Suite. They are also dark, medium-textured and calcareous, but they are distinguished by the presence of flint gravel, stones or boulders.

The definition of series within the Lazaro Subsuite would be useful because the soils are extensive, rather variable, and have a high agricultural potential. There have already been some localized and specifically agriculturally related studies by Christiansen, 1986; (e.g. Wright, 1987). Variations in topsoil texture, profile depth and profile drainage are the most useful criteria.

The soils have been almost wholly cleared of their natural vegetation for agriculture. Some are used for milpa maize and beans, but most are in permanent productive use under sugar cane, although the Mennonite community at Shipyard use these soils for their pasture and cereal cropping system. There are other areas of apparently permanent pasture on these soils to the north of Orange Walk (see Map 2a). The soils have also been used for the recently revived cultivation of cotton, and for BABCO's diversification programme into fruit and vegetables.

The shallower soils tend to be rather droughty, but the deeper non-mottled soils have a good combination of available moisture capacity, free drainage and well-balanced nutrients, and are therefore potentially productive and versatile soils. As can be seen in Table A2.3 they are rated as highly or moderately suitable for the majority of the cropping systems considered. The mottled soils have suspect drainage, and are of lower potential, although still rated as better than marginal for pasture; but their impeded drainage makes them only marginal for sugar cane and irrigated winter fruit and vegetables. Unfortunately, several of the pioneering enterprises with this latter cropping system have been on these mottled soils because they occur on lower slopes where groundwater for irrigation is most accessible. There has been insufficient pumping and transmission capacity to raise the water on to the better-drained soils of the middle and upper slopes.

Pixoy Subsuite

The Pixoy Subsuite contains dark and sandy topped calcareous soils. They are moderately extensive within the Lazaro Plain land system but occupy less area than the soils of the Lazaro Subsuite. They occur in most non-swampy topographic positions. They have been mostly cleared for agriculture, but their natural vegetation appears to be semi-deciduous broadleaf forest, which varies in composition and stature from rather stunted forest to much taller stands with many cohunes.

The topsoil is a black-dark grey loamy sand-sandy loam, weakly structured and very friable. It grades into a grey or greyish brown coarse-textured, weakly structured and friable, lower horizon to a depth of 30-80 cm. There is a moderately strong textural contrast with the horizon below, which is a sandy clay or sandy clay loam. The clay content may well double over a depth range of 30 cm (e.g. profile OZ 1 in Appendix 3) The matrix colour of this lowest horizon is often greyish, brownish or yellowish, with common but not strongly contrasting mottles. The structure is moderate or strong coarse subangular blocky sometimes aggregated vertically to produce a compound coarse prismatic structure. The ped faces have marked shiny clay coatings, possibly of illuvial origin. The consistence is firm – very firm even compact in places but is rooted, particularly by cohunes or other palms. There may be black ferrimanganiferous concretions, and occasional fragments of limestone. In one profile (OZ 65), there were traces of what appeared to be illuvial humus at the base of this horizon.

The boundary between the lowest horizon and the underlying limestone is usually between 1-2 m deep, and is quite sharp. The limestone is weathered and soft sascab, with very pale matrix colours commonly with yellowish patches. As in the Lazaro soils, the sascab often lacks a carapace.

The sandy overwash of dark Pixoy soils deposited on the red and yellow calcareous clays of the Xaibe and Pulucax subsuites (e.g. profile OZ 23) that occur along the western edge of the large body of Xaibe and Puluacax clays in eastern Corozal District are included in the Pixoy Subsuite for the present. Pixoy soils have an approximately neutral reaction but are more or less fully base-saturated, with calcium as the main exchangeable cation. Organic content is moderate-low, despite the dark colours. One profile (OZ 1) has very high available and total phosphate values. The granulometric analyses confirm the abrupt and substantial rise in clay content across the textural contrast boundary. The depth of the coarse-textured topsoil indicate a substantially siliceous parent material. Whether the textural contrast has arisen from inherited layering of the parent material, or pedogenetic clay transfer, or a combination of both is unclear. The change in sand grain size from fine to medium to coarse down Profile OZ 65 suggests sedimentary layering, but the consistency of the increase in clay and the presence of clayskins indicate argilluviation.

The grouping of these soils with those of the Lazaro Subsuite follows the precedent of Wright *et al.* (1959). The soils correspond closely with their Pixoy sets. In Charter's (1941) scheme, these soils are the coarser-textured element of the Orange Walk Series.

In the FAO/UNESCO system, the textural contrast may be sharp enough to qualify these soils as Eutric Planosols. Otherwise they are probably Haplic or possibly Gleyic Luvisols. In the USDA system, they are probably Albaqualfs or Hapludalfs.

The soils are distinguished from the morphologically similar soils of the Lazaro Subsuite by having sandy loam or coarser textures for depths of more than 25 cm below the surface. The Pixoy Subsuite grades the Felipe Subsuite of the Revenge Suite. The distinction is made on the intensity of the colour contrast between the coarse texture horizons and the mottled lower sandy clay subsoil, and by the intensity of the mottling in the sandy clay horizon. The Rockstone Subsuite in the Altun Ha Suite is also dark, calcareous, and has a course-textured topsoil, but the presence of flint stones and boulders, often in profusion, distinguish it from the Pixoy Subsuite.

The Pixoy Subsuite is agriculturally important and is likely to be studied and surveyed in detail (e.g. Christiansen, 1986; Wright, 1987). Subdivision into series will therefore be potentially useful. The soils formed by overwash onto the red and yellow clays of the Xaibe and Puluacax subsuites are obvious divisions, possibly becoming a separate subsuite at some stage. Within the bulk of the dark Pixoy soils, the depth and texture of the coarse topsoil, and the drainage and compaction of the mottled finer subsoils will probably be the most useful criteria.

These soils are used mainly for sugar cane, but also for pasture and cereals at Shipyards. Some of the BABCO-sponsored diversification enterprises into irrigated winter vegetables and fruit are also located on Pixoy soils (Wright, 1987).

The main constraints imposed on crops relate to water; the more severe of these is the tendency to droughtiness in the dry season due to the coarse textures of the upper horizons. In the wet season the compaction and rather slow permeability of the mottled subsoil tend to produce temporary perched water tables, making the topsoil imperfectly drained and partly anaerobic for periods that vary accordingly to the local topographic and hydrological conditions. There are also nutrient deficiencies, especially in the coarse textured topsoil. However, none of these limitations are severe, and the soils are potentially productive and versatile, as can be seen in Table A2.3, in which the better drained soils rate as moderately suitable or better for a range of crops. The mottled soils of lower slopes (particularly subunit W) are assesed as having a lower potential because of more prolonged periods of impeded drainage. It is a pity that the small scale irrigated fruit and vegetable enterprises tend to be located on these soils because of the proximity to groundwater supplies and limited water pumping and transmission capacity. Drainage control would be easier on the soils upslope.

REVENGE SUITE

Revenge Suite soils are formed where moderately thick (between about 70-200 cm) acid siliceous deposits overlie limestone. The acid and calcareous elements produce marked vertical contrasts in morphology, texture and chemistry. The soils are widespread along the New Northern Highway, and patches are found further west.

At present there are two subsuites:

(i) Felipe — Deep slightly acid sands over mottled calcareous medium and fine textured subsoil, over limestone;

(ii) Tok — Variable depth of sand over pale, moderately mottled very plastic and very sticky slightly calcareous clay, over limestone.

Felipe Subsuite

The strongly contrasting soils of the Felipe Subsuite, with deep sandy horizons over calcareous loam or clay subsoils, are not extensive. They tend to occur on the fringes of the deeper siliceous deposits that produce the soils of the Puletan Suite. They also occur in areas of the Pixoy soils where the sandy topsoils are deeper, either because of the vagaries of the original deposition or because they have accumulated by modern wash processes. The distribution of Felipe soils is therefore widespread but patchy, and are mostly found in the San Felipe Plain land system.

The natural vegetation varies from Pine Ridge tree savanna with pines, crabboo, sandpaper tree and a few oak as the main trees to continuous grass cover (see Figure 22 in main text). There are concentrations of palmetto in wetter sites. Where Felipe soils have formed in accumulations of sand close to bodies of open water, there is often a very distinctive mixed woodland. The tree canopy is almost complete so that the herbaceous ground cover is patchy. Large oaks are prominent amongst the trees, and there are other Pine Ridge elements such as crabboo. However, broadleaf species (such as red gombolimbo, sapote, chechem and occasional cohunes) are usually found on the more fertile/ calcareous soils. These woodlands are clearly an ecotone, emphasizing the intergrade nature of the Felipe soils.

The soil profile shows marked discontinuities with depth, resembling an underdeveloped soil of the Puletan Subsuite. The topsoil is shallow, dark, sandy, weakly structured and friable; although it may be deeper and more humic in the wet patches under palmettoes. The topsoil grades into a paler sandy horizon, which ranges in colour from light grey to brown. Textures are still coarser than sandy loam, and structures are weak. This latter horizon varies considerably in depth, exceeding 70 cm in some soils. It overlies, more or less abruptly, a greyish brown-grey sandy clay loam or sandy clay, which has common to many reddish and yellowish mottles, contrasting distinctly if not prominently with the matrix. This horizon is firm to very firm and only slowly permeable. It has a weak blocky structure, which can be massive in places. There are weak clayskins on the ped faces or partings. The horizon tends to be only sparsely rooted. It can go down to considerable depths, but normally gives way to weathering limestone at depths of 70-200 cm. The limestone is pale soft sascab, usually without a carapace of harder stones.

The upper horizons are leached and slightly acid (e.g. a pH of 6-7 in water in Profile OZ 4), but base saturations are generally high. Organic matter and therefore nitrogen levels are only moderate, notwithstanding the dark topsoil colours. Phosphate levels tend to be low. The granulometric analyses confirm the marked textural contrast noted in the field, with clay contents increasing up to five-fold over short distances.

Felipe soils are considered fairly mature. The textural contrast is at least partly attributed to clay translocation, although the weakness of the subsoil clayskins indicates that depositional stratification has probably also contributed, especially where there is hillwash accumulation. The chemical properties, with the near neutral pH and high calcium saturation reflect the ability of plant root systems to draw up cations from the underlying limestone and recycle them through litterfall.

The transitional nature of these soils makes their classification somewhat arbitrary. Some of them are clearly related to the adjacent Pixoy soils, suggesting placement in the Guinea Grass Suite might be appropriate. Others are more like the planosols of the Puletan Suite.

In Charter's (1940) system these soils correspond with the coarsest and most leached end of his widely defined Orange Walk Series. They correlate more or less exactly with the Felipe sets of Wright *et al.* (1959).

In the FAO/UNESCO system the soils are clearly planosols, mostly Eutric, but with possibly some Humic in the wetter patches under palmettoes. In the USDA system they are mostly Albaqualfs, mostly Typic but deeper sandy topsoils make some of them Arenic, and the more humic topsoils under palmettoes may qualify as Mollic, probably Aquollic.

These soils are distinguished from the Pixoy Subsuite in that the lower part of the sandy layer is paler, and the underlying sandy clay is more strongly mottled, with stronger contrasts and brighter mottle colours. The Felipe topsoils also tend to be slightly more leached and acid, which is indicated in the natural vegetation by the elements of Broken and Pine Ridge. Felipe soils are distinguished from Puletan Suite soils by their lack of the characteristic very prominent red and white mottling of the Puletan soils. Felipe soils are also neutral and base-saturated, whereas the Puletan soils are acid and have low or very low base saturations. The distinction from the Tok Subsuite is clear, as Tok has a very distinctive pale plastic calcareous clay subsoil.

The variability of these soils suggest subdivision into series will be useful. Useful criteria will probably be depth and acidity of the sandy horizons, permeability and degree of compaction of the mottled subsoil, and depth to limestone.

Where extensive, Felipe soils tend not to be cultivated but remain under natural vegetation, which may be exploited for pine and oak timber and used for extensive grazing. However, patches of Felipe soils are sometimes included when clearing and developing other soils, particularly those of the Pixoy Subsuite. There are therefore patches of sugar cane, pasture, sorghum and irrigated fruit and vegetables on these soils. They are normally left alone by milpeiros, but some patches of milpa maize and beans were seen.

The main constraints imposed by these soils are droughtiness in dry weather, impeded drainage in wet weather and generally low levels of nutrients. As shown in Table A2.3 these soils are assessed as no better than marginally suitable, and then mostly for the less demanding cropping systems such as coconuts, pasture and pineapples.

Tok Subsuite

The strikingly duplex Top Subsuite soils occur where the early Pleistocene drift on the Northern Coastal Plain is thin – consistently less than 2 m and overlies Late Tertiary limestone. The natural vegetation is poor Pine Ridge tree savanna, with few stunted pines, some crabboo, no oaks, and a relatively high proportion of small calabash trees and shrubs. The grass cover is often tussocky and sparse. There are scattered palmettoes, which tend to be more concentrated in wetter patches.

The surface consists of bare soil and grass tussocks. A distinctive feature is the common occurrence of snails and their relict shells. This calcareous indicator is unexpected in a vegetation that is so characteristic of oligotrophic conditions. The topsoil is moderately dark coloured, sandy, weakly structured and friable. It grades into a paler sandy horizon, also weakly structured and fairly friable, which more or less abruptly overlies the horizon that distinguishes these soils: a pale – usually white – clay which is distinctly mottled with yellowish and brownish colours. This characteristic lower horizon is usually massive or coarse blocky, with only weak clay coatings on ped or parting faces. Its consistence when moist-very moist is extraordinarily plastic and sticky. The horizon is calcareous and may contain limestone fragments. There may also be black ferrimanganiferous concentrations, both soft stains and hard concretions, which are particularly concentrated near the limestone fragments.

The horizon grades into a more strongly mottled pale coloured clay at depth – characterized by bright reddish patches – which has a slightly more pronounced blocky structure and lacks the extreme plasticity and stickiness that characterizes the overlying white clay. It also contains more limestone fragments and may also have clusters of gypsum crystals.

The soil chemistry is also distinctive. The topsoil is moderately acid (pH 6 in water) and contains few exchangeable bases (e.g. the exchangeable bases in the topsoil of profile OZ 21 sum only 1 m̊Eq̊/100 g fine earth). The subsoil is quite different. It is moderately alkaline at about pH 8.5 in water, and fully base-saturated with total exchangeable bases (TEB) up to 30 m̊Eq̊/100 g fine earth.

At first sight, the Pine Ridge vegetation and the marked duplex profile suggest a variant of the Puletan Suite, and should be classified as a subsuite in that suite; but the chemical characteristics, the presence of limestone and gypsum, and the physical properties of the white clay are quite unlike the Puletan Suite, and indicate separate status at suite level. The grouping of Tok with Felipe in the same suite is rather arbitrary as the soil morphologies are quite different. It is the similarity of the parent materials that indicate they should be grouped.

In Charter's (1940) system a number of acid topsoils over calcareous clays are mentioned: Tower Hill, Rockstone Pond and Kate's Lagoon series. Of these only Rockstone Pond is mentioned for its subsoil plasticity. The subsuite appears to correspond well to the Tok set of Wright *et al.* (1959) although they make no mention of the exceptional soil consistence.

In the FAO system the textural contrast qualifies these soils as Planosols, probably Eutric but possibly Gleyic. In the USDA system they are probably some kind of Albaqualf, although their correct subgroup placement is not clear.

The differences from other subsuites have already been mentioned in the discussion of the classification. Only Tok has the characteristic white plastic and sticky clay.

These soils have low agricultural potential, and it seems unlikely that they need to be surveyed in detail. Subdivision into series is therefore unlikely to be necessary. If it were to be done, the depth and drainage status of the sandy topsoil, and the intensity of the subsoil plasticity and stickiness are probably the best criteria.

These soils are almost completely unused. The only significant development is some road construction in the Revenge Lagoon area, apparently in preparation for subdivision into residential/recreational lots.

The physical conditions in the subsoil clearly impose severe constraints on plant roots, as indicated by the poverty of the natural vegetation. Mechanical impedance and poor aeration largely exclude roots from the plastic and sticky white clay. The root systems, restricted to the fairly shallow sandy topsoil, suffer from severe moisture shortages in dry weather. There are also thought to be severe nutrient shortages and imbalances. The soils are therefore rated as unsuitable for most cropping systems, as can be seen in Table A2.3. There may be some patches that are marginally suitable for pasture, rice, irrigated vegetables and pineapples, but these soils are generally best left alone.

Because of their very distinctive pedological and edaphological characteristics, the soils will need detailed studies. The creation of some kind of ecological reserve, not necessarily large, will ensure the long-term conservation of at least some of these soils and their vegetation.

Altun Ha Suite

The Altun Ha Suite contains medium- and coarse-textured soils formed on the flinty crystalline siliceous Doubloon Bank Group limestones that underlie the eastern part of the Northern Coastal Plain (Jobo Plain land system) astride the Old Northern Highway. The limestone produces a pock marked landscape with many sinkhole ponds. The suite is named after the important Maya site in the area.

The characteristic feature of these soils is the presence of flints, often in abundance. There are two subsuites:

(i) Jobo — Medium- or fine-textured fine earth fractions throughout the profile;

(ii) Rockstone — Coarse-textured fine earth fraction in the upper horizons.

Jobo Subsuite

The soils of the Jobo Subsuite are more extensive than those of Rockstone. They alternate with patches of Tok soils. They occupy all topographic positions from the low broad crests to the lower slopes adjacent to the numerous swamps and ponds. Their natural vegetation has been much disturbed but appears to be semi-deciduous broadleaf forest, often with a high proportion of cohunes.

The surface of these soils may be quite stony. The stones are mostly flints, ranging from grit to boulders up to 75 cm across. There may also be fragments of the limestone which appears harder and more crystalline than most others in the project area. It fractures with sharp angular edges and planar or slightly conchoidal faces.

Stones are found throughout the profile. They may be evenly distributed or, more commonly, they are concentrated as a mid-profile stone line, or as a carapace on top of the underlying limestone. The content and distribution of stones is laterally very variable, as in Profile OZ 57. The described face has a distinct flint stone line at 10-26 cm depth. On the opposite face, less than a metre away, flints are distributed in great profusion throughout the solum.

The fine earth profiles of these soils are rather variable, varying from shallow and well-drained soils of various colours to deep grey soils with somewhat impeded drainage. The topsoils are dark, with very dark grey the commonest colour but blacks, greys and dark browns are also found. Fine earth textures are sandy clay loam or sandy clay. Sandy loams may also occur, but if they persist below 25 cm, they qualify the soil as a Rockstone rather than a Jobo. Where stones permit, structures are fine-medium subangular blocky, breaking to crumb. Between the stones the consistence is quite friable. In the better drained soils this grades into a lighter grey, reddish or brown subsoil horizon, with a tendency to finer texture, coarser structure and firmer consistence than the topsoil. The blocky structures have moderate and rather patchy clayskins. In the shallower soils, this horizon overlies limestone, which starts at 25-60 cm depth, with or without a carapace of flint, other hard siliceous rocks or angular hard fragments of the limestone itself. The underlying limestone may be soft and weathered enough to qualify as sascab, but many of these limestones are hard, and weather only slowly.

The deeper soils in lower slope positions (subunit 'W') have light grey or pale brown subsoils which are faintly or distinctly mottled with greys, browns and yellows. There may be a distinct olive yellow horizon just above the limestone. This lower part of the subsoil often contains many black ferrimanganiferous concentrations, either soft stains or hard concretions. The underlying limestone tends to be softer and more weathered than that under the shallower soils upslope (e.g. Profile OZ 58).

There is an additional and rather distinct group of soils which are included in the Jobo Subsuite for the present. They are located on the southern edge of the large body of Xaibe and Puluacax clays in eastern Corozal District. They are characterized by dark, medium- or fine-textured and flinty upper horizons overlying subsoils of the yellow calcareous clays typical of the Puluacax Subsuite, and less commonly, the red calcareous clays of the Xaibe Subsuite. Profile OZ 49 is an example with a yellowish Puluacax-type clay subsoil.

The chemical characteristics of Jobo topsoils appear to be affected by the siliceous nature of the parent material. They are midly acid (pH in water about 6-7) and have slightly less than total base saturation. The subsoils are alkaline (pH in water >8) and fully base-saturated, with calcium as the dominant exchangeable cation. Organic matter and nitrogen levels are moderate but probably rather variable. The granulometric analyses confirm the medium field textures, and show considerable increases in clay content with depth.

The soils are formed in parent materials derived from the underlying flinty limestone. The occurrence of apparently buried topsoils and of stone lines, which include artificial flint flakes and occasional potsherds, suggest many of these materials are slopewash. They may have been emplaced during the massive agricultural deforestation by the ancient Mayas (J. Jacobs and C. T. Hallmark, 1990, personal communication). Since emplacement there appears to have been substantial textural segregation, with a doubling of clay content with depth in some cases. If this has developed within the last millenium, argilluviation may be more rapid in this area than is conventionally acknowledged, which also lends credence to Wright *et al.*'s (1959) suggestion that textural profiles can be considerably modified within a few years or decades by certain types of agriculture and soil management.

The soils are separated from other dark medium textured calcareous soils, such as those of the Lazaro Subsuite in the Guinea Grass Suite, on account of the flints, and their indications of differences in parent material lithology.

The soils correlate with the Jobo sets of Wright *et al.* (1959). The equivalence to the Maskall Series of Charter (1940) is less clear as they also appear to resemble his Rockstone Pond Series in texture and flint content. In the international systems some of the shallower soils are Rendzic Leptosols (FAO/UNESCO) or Rendollic Eutropepts(USDA). The deeper soils are Eutric Cambisols or Haplic or Chromic Luvisols (FAO/UNESCO) and Eutropeptic Rendolls or Hapludalfs (USDA).

As noted these soils differ from most others on account of the flints or related quartzose stones. The only other flinty soils are those of the Rockstone and Jolja subsuites. Rockstone soils have a coarser fine earth texture. The Jolja soils are generally fine-textured, with clay fine earth fractions. There is also a geological/geographical difference as Jolja soils occur on a different, assumedly older, relatively non-crystalline limestone in the far west of Belize.

There may be a need for detailed soil surveys of these soils in the future in view of their moderate agricultural potential and patchy distribution. Depth and drainage are obvious criteria for series definition. There is also scope for series separation based on the colour and texture of the subsoil fine earth, with the yellowish clays being an obviously distinct group. The red and grey soils may also be differentiated.

The area occupied by these soils has long been accessible due to the old Belize-Corozal road. There have been a wide range of agricultural enterprises over the years. Many of these have failed or contracted, but some of these soils are still used for pasture, coconuts, mangoes, pineapples (especially on the Corozalito road) and maize.

The main limitations to crops are the tendency to droughtiness and the cultivation problems caused by the coarse and sharp flintstones. There are also nutrient deficiencies. Nonetheless the better-drained of these soils are assessed as moderately suitable for the more drought-tolerant crops that do not require intensive cultivation, such as pastures, pineapples, coconuts and sugar cane. The deeper mottled soils are less droughty, but their drainage and aeration are mediocre, and they are generally assigned worse suitability ratings in Table A2.3.

Rockstone Subsuite

These flinty and sandy soils of the Rockstone Subsuite are the coarse-textured equivalents of the Jobo soils. They are less extensive, but occupy the same general area, astride the Old Northern Highway in the Jobo Plain land system. They tend to be more concentrated in the southern part of this area, around Sandhills-Salt Creek-Ladyville. Their natural vegetation is rather low and open semi-deciduous broadleaf forest, in which sapote, chechem and other drought-tolerant and calcicole species are prominent. In places the forest is open enough to permit a herbaceous ground cover, sometimes with cutting grass.

The profile is similar to that of Jobo but generally coarse-textured. The soils are generally very stony, with many flints, and angular fragments of hard crystalline limestone up to 50-80 cm across in places, as a surface pavement, a subsurface stone line, a carapace above the weathering limestone or evenly distributed throughout the solum. These stones are more abundant than in Jobo soils, and make auger examination of the deeper subsoils almost impossible. They give the impression that the soils are very shallow.

The topsoil fine earth is grey or greyish brown, loamy sand or sandy loam, friable, and has weak blocky or crumb structures that tend to crumble to single grain. The topsoil grades into grey or brown sandy clay subsoil, with moderate-medium blocky structures which have moderate patchy, clay coatings. The consistence appears firm, although the stones make it difficult to determine. The subsoil usually overlies weathering limestone (sascab), with or without a carapace stone line. In the profile examined in detail (Profile OZ 89 in Appendix 3), it is underlain by blotchy pale coloured clay that is almost stone-free, but this is not thought to be a particularly widespread feature. It is thought to be relict mangrove mud, uplifted when the land emerged from the sea. It probably occurs in Profile OZ 89 because of its proximity to the coast.

There is probably a range of depths and drainage status in this subsuite similar to that found in the Jobo soils; but the universally high stone contents prevented augering to any depth, so deep and mottled variants of the generalized profile described above were not seen.

The chemical characteristics reflect the siliceous contribution in the topsoils with the soil reaction neutral or slightly acid, and the cation exchange capacity not fully base-saturated. The subsoil is much more calcareous, with pH in water about 8 and with total base saturation, mainly by calcium. The granulometric analyses confirm the coarse textures in the topsoil and the marked increase in clay with depth.

The profile examined appeared to be formed in a polysequent parent material with flinty sandy slopewash over relict coastal mud over limestone. The extent to which the other soils are formed in mobile allochthonous materials is unclear. If many of these soils are slopewash, the textural changes with depth may be partly depositonal but argilluviation is probably also important, as indicated by the invariable increase in clay content with depth, rather than random variation, and also by the subsoil clayskins.

The classification of these soils in the Altun Ha Suite is based on the presence of flints. The Rockstone soils are rather less fertile than the soils of the Jobo Subsuite, but the grouping together seems justified by the similarities of the natural vegetation and by the close spatial association.

Their correlation with earlier studies is not entirely clear. The Rockstone Pond series of Charter (1940) is a finer textured flinty soil, apparently resembling Jobo Subsuite rather than the present Rockstone soils. Wright *et al.* (1959) also have a Rockstone soil. Its texture also tends to be finer than the current Rockstone Subsuite, but it is clear from their general description of the area that they envisage it as a rather coarse textured, acid and infertile soil, therefore matching the general concept of Rockstone Subsuite as used here.

In the international systems, the shallowness and stoniness of these soils probably qualify most of them as Eutric or Rendzic Leptosols (FAO/UNESO) and Rendollic Eutropepts (USAD). A few of the deeper and less stony profiles may qualify as Cambisols or Luvisols (FAO/UNESCO) and Hapludalfs or Rendolls (USDA).

The soils are easily distinguished in the field on account of their high flint contents. The only other very flinty soils are those of the Jobo and Jolja subsuites. Both of these have fine- or medium-textured fine earth fractions and are rather more fertile. Their flint contents are variable but tend to be lower than in the Rockstone soils.

A large area of these soils is currently being redeveloped for citrus on the old Salt Creek Estate. The main crop is limes but other citrus are also being planted.

In the vicinity, there are also smallholdings with citrus, coconuts, various fruit trees and some pineapples.

The main limitations on crops are droughtiness, due to the shallowness, high stone contents and coarse texture, and the poor supply of some major nutrients. The high stone contents also constrain cultivation. These constraints are reflected in the low assessments for arable crops in Table A2.3. The soils are rated as marginally suitable for a number of the less demanding tree crops.

STOPPER SUITE

The Stopper Suite includes all of the residual, hillwash and colluvial soils derived from granitic parent materials. In the project area, they are restricted to the Maya Mountains in southern Cayo district.

There is a wide range of morphological variation in the suite. Common features include high contents of angular quartz sand or grit set in a relatively fine textured matrix, giving the soils a binomial granulometric distribution; which is thought to account, in part at least, for their relatively high erodibility. Once in motion, the sharp quartz grains easily abrade the matrix to produce rapid gullying. The granites are therefore relatively incompetent. Granitic soils are therefore often found at lower altitudes than the surrounding soils developed on the less erodible metasediments of the Maya Mountains.

The granitic soils at the low altitudes were examined during the survey of Stann Creek District (King *et al.*, 1989). Their presence in the current project area is inferred from the geological map of Bateson and Hall (1977). These low altitude soil subsuites are described here only briefly:

Powder Hill	– Shallow grey soils
Mayflower	– Moderately deep pale coloured loams
Canada Hill	– Deep red loams and clays

For more details, profile descriptions and analyses, reference should be made to the Stann Creek Report (King *et al.*, 1989). The other subsuite – Pinol – includes the granitic soils of the Mountain Pine Ridge and is treated here in more detail.

Powder Hill Subsuite

The Powder Hill Subsuite includes all of the shallower and stonier soils that tend to occur on steep and actively eroding slopes at low and intermediate altitudes. They are widespread in the mountainous areas, and in convex sloping areas along actively dissecting streams. The natural vegetation is semi-deciduous broadleaf forest, often with a high proportion of cohune palms.

Beneath a moderately dark topsoil, the soils are characterized by pale colours, ranging from pink through yellow to grey. They tend to be coarse or medium textures, with only moderate increases in clay content with depth. They are generally shallow, often with granitic corestones in the top 30 cm, and grade to moderately friable weathering granite within 60 cm. The soils have weak or moderate fine blocky structures, that crumble to single grain, and friable consistences throughout. Their textures and structures make them permeable and freely drained. They are moderately leached and acid, with low contents of exchangeable basic cations, including potassium, despite the presence of extant muscovite flakes. Phosphate and nitrogen levels are low.

The soils are mostly still under forest. Because they are found on steep slopes and are erodible, they should remain forested, and the forests should be managed primarily for soil, water and general conservation. Logging should be banned from most of them, and carefully controlled where it is permitted.

Milpa farmers have generally been disappointed by low productivity on these soils. Despite the promise of the relatively good-looking forest, first crops after clearing and burning are poor and the rate of recovery of the subsequent wamil is very slow. Milpeiros should be actively discouraged from even entering these areas. Similarly, permanent agriculture, even tree crops, should be proscribed because of the low productivity and high erodibility of these soils. The shallowness, stoniness and coarse textures make them rather droughty. They also have nutrient deficiencies and imbalances, and tend to need liming and fertilization, especially for phosphate; but overriding considerations of erodibility affect the poor ratings of these soils in Table A2.3.

Mayflower Subsuite

The Mayflower Subsuite contains pale coloured residual hillwash and colluvial granitic soils of moderate or greater depth at low and intermediate altitudes. They probably only occur as pockets within the shallower soils of the Powder Hill Subsuite. They can occur on quite gentle slopes where the underlying granite is leucocratic, and the initial iron content of the soil's parent material is low. In the project area, they are more likely to occur on a wider range of granites on moderately steep slopes, where erosion and profile truncation keep the soil in a state of arrested development. The total iron content of the granite is incompletely weathered and rubefaction is therefore not intensive. The natural vegetation is semi-deciduous broad-leaf forest, often with many cohune palms.

The topsoil is a generally dark grey loamy sand to sandy clay. Structure is weak crumb or fine blocky, crumbling readily to single grain. Consistence is friable. The subsoil ranges in colour from light grey to bright yellow. It is finer textured than the topsoil, usually sandy clay loam – sandy clay. The sand is predominantly coarse and consists of angular quartz grains. The structure is weak – moderate to moderate subangular blocky, with moderate and discontinuous clayskins on the ped faces. Consistences are generally still slightly friable. The pale colours are attributed to low contents of free iron sesquioxides. They do not indicate impeded drainage. The soils are permeable and drain readily. They are leached, acid and have low contents of available nutrients, especially calcium and phosphate.

In the project area, the areas identified as possibly having these soils are still under forest. In Stann Creek District the soils on gentler slopes have been cleared for milpas and for permanent tree cropping, especially citrus (King *et al.*, 1989).

These soils suffer from the same erodibility limitations as the other granitic soils. Initial moderate overland flow seems to lead rapidly to sheet and then gully erosion, probably because of the erosivity of the coarse sharp quartz sand. Where these soils occur on slopes steeper than about 12°, they should be left under protective forest.

The few patches on gentler slopes could be developed for agriculture, but are so inaccessible that it is very unlikely in the foreseeable future. Even on shallower slopes, soil conservation needs to be an integral part of management with care taken to minimize cultivation and exposure of bare soil. The soils tend to be slightly droughty where shallow, but the deeper soils combine free drainage and good aeration with moderately available water capacities. The soils need considerable liming and fertilization, especially with phosphates, in order to be productive. They are therefore more suited to commercial operations with substantial inputs. Because of the erosion risk, arable cropping should be discouraged. Tree crop management must include considerable attention to maintenance of complete ground protection. Milpa farming has proved disappointing: the apparent promise of the natural vegetation has been confounded by poor first crops and slow recovery by the subsequent wamil. Given the erodibility of these soils, cultivation should be very actively discouraged.

Canada Hill Subsuite

Canada Hill Subsuite soils are the deeper and redder residual and hillwash granitic soils of low and intermediate altitudes. They occur on moderate and gentle slopes over melanocratic granites with at least moderate iron contents.

None were seen during fieldwork, but they are thought to occur as small patches in the areas identified as granite on the geological map of Bateson and Hall (1977). In the project area, they are all under tall semi-deciduous broadleaf forest with a high proportion of cohune palms.

The topsoil is shallow, commonly dark grey, greyish brown or reddish brown. The textures are generally moderate to fine, with a predominantly coarse sand fraction with sharp quartz grains. The subsoil is red and fine- or medium-textured, ranging from sandy clay loam to clay. There is usually substantially more clay in the subsoil than in the topsoil. The subsoil structures are weak blocky that crumble readily to crumb, with clayskin patches on some block faces. The consistence is generally moderately friable in the hand, but there may be a fragic tendency to *in situ* compaction in some profiles. The profile is usually moderately deep, with weathering granite at or below a depth of 60 cm - sometimes as deep as 2 m.

Canada Hill Subsuite soils are the most developed of the granitic soils. The advanced weathering has liberated most of the initial iron content of the granite, to become free sesquioxides which, with the 1:1 aluminosilicates dominate the clay minerals producing the intense red colours, crumb structures and friable consistence in the subsoil. The stable aggregation of the subsoils makes these soils more permeable and free draining than their fine textures suggest. The soils are well leached and acid, and they lack nutrients especially calcium and phosphate. Aluminium is usually the dominant cation in the subsoil. There is a tendency to phosphate fixation by the iron sesquioxides.

Although formed by prolonged pedogenesis in relatively stable sites, these soils share the granitic tendency to erodibility of the sharp coarse quartz grains. However, their agricultural potential is mainly limited by nutrient constraints. Physically they combine free drainage with moderately high reserves of available moisture, but they require heavy liming and phosphate fertilization to be productive. They are therefore more suited to commercial agriculture than subsistence small-holdings. Because of the erosion risk, they should not be used for arable production. If put under tree crops, great attention must be paid to soil conservation with particular emphasis on the maintenance of a complete ground cover.

Milpa cultivation has produced poor crops and slow recovery in the wamil phase. Because of the erosion risk further milpa cultivation should be vigourously discouraged.

Pinol Subsuite

Pinol Subsuite soils are the residual, colluvial and hillwash soils formed on the granites of the Mountain Pine Ridge. These granites have low to moderate iron contents and, elsewhere in the Maya Mountains, they are less resistant to weathering and erosion than the adjacent metasediments of the Santa Rosa Group. They therefore tend to occupy the lower terrain in the Mountain Pine Ridge. Nonetheless the granitic terrain can be quite rugged, with slopes ranging from rolling to steep. The soils are found in all topographic positions from crest to drainage line. The natural vegetation on well-drained slopes is the tree savanna of the Mountain Pine Ridge. *Pinus caribaea* is the dominant tree, with subordinate oaks, crabboo and *Miconia* spp. The density of the pine stand appears to be mainly determined by the history of the site, particularly its disturbance by fire or logging. The ground cover is mainly calcifuge grasses, but there are also dense patches of *Hypericum* sp., and occasional ground orchids. Minor drainage lines may contain patches and strips of palmettoes and dumb cane. Wider drainage lines contain a dense and diverse semi-deciduous or almost evergreen low broadleaf forest.

There have been a number of studies of the distribution and ecological relationships of these soils (Darcel, 1952a and b; Birchall, 1973; Furley, 1968, 1974b; Kellman, 1975, 1979; Kellman and Miganashi, 1982; Kellman *et al.*, 1987; Miyanashi and Kellman, 1988). From these and our own field observations it is clear that there is a considerable variation in soil morphology in this subsuite. The main soils of the slopes on the more melanocratic granites are characterized by bright red and yellow colours and moderate depth with a very diffuse gradation to the underlying weathering granite. In stable sites the topsoil may be shallow and moderately dark (e.g. Profile OZ 38 in Appendix 3). In other sites the profile appears to have been recently truncated and lacks a melanized topsoil (e.g. Profiles OZ 41 and OZ 80). Topsoil textures vary from loamy coarse sand to clay loam, but are mainly in the sandy loam-sandy clay loam range. Topsoil structures are weak or moderate crumb or fine blocky, with a tendency to break to single grain in the coarsest soils, or to fine crumb in most of the others. Subsoil colours tend to get redder with depth. A common sequence is brownish yellow over yellowish red (e.g. Profile OZ 38). On the more leucocratic granites, the initial iron and the subsequent iron sesquioxide contents are too low to produce intense rubefaction and yellow or grey colours predominate (e.g. Profile OZ 41). Conversely, on the most melanocratic granites the free iron sesquioxide contents are high enough to give red colours throughout the solum (e.g. Profile OZ 40).

Subsoil textures vary from sandy loam to clay, with sandy clay predominant. Structures tend to be weak–moderate blocky, breaking to moderate crumb in some soils. Increases in clay content with depth are usually accompanied by moderate clayskins on some block faces, but there are some soils in which clay does not increase with depth. Consistence tends to be moderately friable in the hand, but there is a fragic tendency to *in situ* compaction. These latter soils are fairly difficult to auger and dig. There may be some black ferrimanganiferous concretions in the lower part of the subsoil.

The lower subsoil also becomes more mottled with depth and grades into variegated red, white, yellow and brown weathering granite. The boundary is hard to determine but is generally shallower than 1.5 m. There may be black manganiferous staining in the weathering granite, especially along joint planes.

Most of the soils appear to have developed from intense *in situ* weathering (e.g. the residual quartz vein to within 30 cm of the surface in Profile OZ 38). There has also been some argilluviation, possibly including some movement of the sesquioxides to produce the redder subsoils; but the soils are erodible and some of them have been truncated. These may also be some selective sheetwash erosion of finer components, contributing to the coarser topsoil textures.

In the western part of the Mountain Pine Ridge, there is a discontinuous band of deeper and wetter granitic soils, apparently formed in hillwash or alluvium deposited by streams flowing westwards towards the Macal River. These streams may have been impeded or ponded by the resistant limestone. The vegetation is noticeably different from the better drained soils in the rest of the granitic Mountain Pine Plateau. There are more sedges, palmettoes and dumb cane, and fewer and more stunted *Pinus caribaea* and crabboo. Beneath a shallow darkened topsoil, the profile consists of pale coloured loamy sand – sandy clay. Matrix colours are yellow, light grey or white, often with yellow, brown and black mottles. The soil is moist in the upper horizons but quite wet at depth. There is often a layer of black ferrimanganiferous concretions, sometimes partially cemented into proto-ferricrete. Subsoil structures are weakly blocky, and consistences are friable – loose. The wet lower subsoil continues to well below 1.5 m depth, sometimes taking on greenish tinges in the matrix colours (e.g. Profile OZ 79).

The soils of the toe slopes and drainage lines throughout the plateau area tend to be deeper and wetter than those upslope. Topsoils are considerably darker and contain more organic carbon and total nitrogen,. Subsoil matrix colours are paler, and the soils are often mottled. Textures may be more variable due to hillwash layering, although clay contents still generally increase with depth.

Although not deep, these soils all appear to be well leached. They are acid (pH in water 5-6) and base-deficient with base saturations usually well below 50% and often less than 25%. Aluminium is the dominant exchangeable cation in the subsoils. Organic carbon and total nitrogen levels are only moderate in the topsoils, and drop to low levels in the subsoils. Available phosphate levels are low and perchloric acid-extractable total phosphorus contents are very low.

The grouping of all of these soils into one subsuite is debatable. The better-drained soils may merit a separate subsuite from the deeper wet grey soils in the hillwash and alluvial deposits, in the western part of the Mountain Pine Ridge.

Charter (1941) distinguished a Blancaneau series as the granitic member of his Croja suite of Mountain Pine Ridge soils. From his brief description, Blancaneau series appears to be one of the more coarse textured and pale-coloured of the Pinol subsuite of this study. These soils are clearly equivalent to the granite soils in Darcels' (1952a and b) studies. He distinguishes the darker moister soils of the 'draws' (i.e. drainage lines), but otherwise does not differentiate or attempt to map these soils, despite substantial fieldwork. Wright *et al.* included all of the main Mountain Pine Ridge soils in their Pinol sets. The well-drained granite soils of this study's Pinol Subsuite are equivalent to their Pinol coarse sandy clay loam (Set 52) and rocky sandy clay hill soil (Set 52H). The greyer and wetter hillwash soils of the western Mountain Pine Ridge appear to relate to the various Pinol Set soils of their Vaqueros Subsuite (Sets 52d, 52e, and 52f).

Birchall (1973) used the names of Wright *et al.*, and named his granitic soil as Pinol coarse sandy clay loam, which he separated from the dark creek soils and from the deeper and sandier Pinol loamy coarse sands on old river gravels in the western parts of the Mountain Pine Ridge. His study is particularly informative because it includes conventional profile descriptions. Kellman and his co-workers (Kellman 1975, 1979; Kellman and Miyanashi, 1982; Kellman *et al.*, 1987; Miyanashi and Kellman, 1988) were concerned with be ecological relationships of soils rather than their pedology or distribution. Their work has been particularly interesting in showing that the weathering of the granite, despite being fairly shallow, appears to contribute little to the nutrition of the pines. Apart from the nutrients that are biologically recycled, the trees' supplies are augmented mainly from atmospheric sources.

In the international systems, the shallower and more truncated of the slope soils correspond approximately with the Dystric Cambisoils (FAO/UNESCO) and the Oxic and Typic Dystropepts (USDA). The deeper soils may have sufficient textural contrast to qualify as Dystric Planosols in the FAO/UNESCO system. The others are Haplic Acrisols (FAO/UNESCO) where there is still a substantial increase in clay with depth (e.g. Profile OZ 40) or Haplic Ferralsol where there is no argic horizon (e.g. Profile OZ 3) at all. The deeper slope soils are probably mostly Hapludults or Paleudults in the USDA system, but there are some Hapludoxes where there is no argilluviation. The drainage line soils are mostly Humic or Gleyic Acrisols (FAO/UNESCO) or Tropaquults (USDA), although profiles showing obvious depositional layering may be Dystric Fluvisols (FAO/UNESCO) and Tropic Fluvaquents (USDA). The deep, grey hillwash and alluvial soils of the western Mountain Pine Ridge are also likely to be Gleyic Acrisols (FAO/UNESO) and Haplic or possibly Plinthic Tropaquults or Paleaquults (USDA).

Pinol Subsuite soils are relatively easy to distinguish from those of other subsuites. They are distinguished from the rather similar adjacent soils of Cooma Subsuite by the presence of plentiful angular quartz grit in the solum and the presence of underlying weathering granite rather than medasediments. They can be morphologically distinguished from other granitic soils in having a more pronounced subsoil compaction. There is also a major ecological and geographic distinction since the other granitic subsuites are soils of low and intermediate altitude and their natural vegetation is broadleaf forest, whereas the soils of the Pinol Subsuite are restricted to the Mountain Pine Ridge at altitudes above 500 m and support *Pinus caribaea* savanna. Some soils in the Puletan Suite bear some resemblance to these soils. However, they can be distinguished by their more pronounced textual discontinuity, the more variegated red and white mottling and greater compaction of the subsoil, and the lower contents of angular quartz grit. They also occur in quite different environments on the coastal plain.

If future silvicultural or ecological studies wish to distinguish these soils in more detail, the morphological variations described above provide the basis of a series classification. Potential slope series include pale coarse-textured, yellowish over red medium-textured and red fine-textured, each with or without a melanized topsoil. Further series can be defined for the darker and wetter drainage line soils, and for the poorly drained deep hillwash and alluvial soils in the west.

The soils lie almost entirely within the Mountain Pine Ridge Forest Reserve, and are managed by the Forestry Department as a productive forest. Growth of the pines is slow; the logging in return period appears to be of the order of 50-70 years. There has been considerable investment, mainly in fire protection and in a system of roads to allow for rapid access for fire-fighting. In the past, a number of agricultural enterprises have been initiated, notably the sheep grazing project of the Commonwealth Development Corporation (CDC), but all have failed. At present there are small patches of young cocoa, coffee and citrus. These may survive and bear some fruit but they are not expected to prove very successful.

There are a number of limitations on the agricultural suitability. The compaction and acidity of the subsoils make inhospitable root environments, and the relatively sparse rooting tends to produce rather droughty soils. The nutrient deficiencies and imbalances are also major constraints. Liming and correctly balanced fertilization of these soils is likely to be expensive and demands skill. These major problems are reflected in the agricultural suitability assessments in Table A2.3. Only pasture is rated as even marginally suitable. The soils should remain under forest, with attention to their potential as a recreational and tourist resource as well as a source of timber. All systems of management should take note of erodibility of these soils (e.g. Francek, 1988), especially in view of the importance of the Mountain Pine Ridge as a major source of surface water for much of central Belize.

OSSORY SUITE

The Ossory suite includes all the residual and hillwash soils derived from the metasediments of the Santa Rosa Group (Bateson and Hall, 1977). Within the project area they occur in the Maya Mountains of southern Cayo District.

The metasediments are mainly quartzitic sandstones and various argillites but range greatly in grain size and degree of metamorphism. They therefore give rise to a wide range of parent materials and soils.

As in the Stopper Suite, there are a number of soils that occur at low and intermediate altitudes in the rugged mountainous terrain in the eastern part of Southern Cayo, the presence of which has been inferred from airphoto interpretation. They were not seen in the fieldwork for the present study. They are described only briefly here. Reference should be made to the Stann Creek report (King *et al.*, 1989) for more details, on the low altitude subsuites, i.e.

Cabbage Haul	Shallow grey and brown soils;
Curassow	Deep residual red soils of fine texture;
Pippen	Moderately deep red residual soils of coarse and medium texture;
Dancing Pool	Deep red and brown hillwash soils.

The other soils occur at higher altitudes and were not described in the Stann Creek report, and are therefore treated more fully here. They are:

Granodoro	Shallow reddish variable textured soils at intermediate altitude;
Machiquila	Deep reddish hillwash soil from argillites, underlying limestone;
Chiquibul	Shallow soil of variable texture at high altitude;
Cooma	Main metasedimentary red and yellow soils of the Mountain Pine Ridge;
Baldy	Grey and yellow prismatically structured soils of the Bald Hills.

Cabbage Haul Subsuite

Cabbage Haul Subsuite soils are the shallow and stony soils that occur on the predominantly steep slopes of the Maya Mountains. They are very extensive, but were only briefly examined in the Stann Creek survey because of their inaccessibility and obviously low potential. They were not examined at all in this survey but are undoubtedly extensive. They are mostly under semi-deciduous broadleaf forest, but where there have been frequent fires, either anthropogenic or caused by lightning strikes on ridge chests, the forest is replaced by low scrub dominated by the fern tiger bush. This is very persistent and is only slowly re-invaded by forest, which appears to have a higher proportion of pines than the original cover.

The profile may have a shallow, darkened topsoil often strong with a weak-moderate crumb structure, but some of the soils are on steep and unstable sites and are therefore frequently truncated. The stony subsoil is predominantly grey or brown, although some reddish colours are also found. Variations in colour result from incomplete weathering not impeded drainage. Subsoil structures are weak-moderate medium blocky. The subsoil overlies the fairly hard rock at depths ranging from 10-50 cm. The predominant textures in the soil depend on the proportions of sandstone and argillite in the parent material. Many are coarse- or medium-textured – sandy loam or coarser – because the harder quartzitc sandstones are less erodible that the argillites. They therefore form the positive relief features which give the steep slopes on which these soils occur, but there are also argillite ridges and steep slopes, and consequently fine-textured Cabbage Haul soils.

The soils of this subsuite are leached, acid and base-deficient. They are also often low in organic carbon and total nitrogen. Both available and total phosphate levels are often low, but appear to be variable. Because of their erodibility these soils should remain under their current fairly undisturbed forest, which should be managed for protection rather than production, and logging should be excluded. The rare patches of these soils that occur on gentler slopes should also be left under forest because they are of low agricultural potential anyway, even discounting the erosion risk. Their shallowness, stoniness and generally coarse textures make them very droughty. In addition, they have severe nutrient limitations and would require liming and fertilization to be made productive.

Currassow Subsuite

The Currassow Subsuite contains the deeper residual soils of fine texture, mainly derived from the weathering of the various argillaceous metamorphic rocks. They tend to occur on gentler slopes than the soils of the Cabbage Haul Subsuite, but in Stann Creek District they were seen on slopes of up to 25°. They often occupy mid and lower slope positions or remnant plateaux or crests that are only slightly dissected. They are thought to be relatively inextensive in the project area, but are probably present in widespread small patches. The natural vegetation is tall and diverse semi-deciduous broadleaf forest.

The soils are distinctly red. The topsoil is usually dark brown, dark reddish brown or reddish brown, and has a loam-clay loam texture with a moderate or stony crumb or fine blocky structure. It is normally fairly friable. In shallower soils it grades into a reddish clay with a moderate blocky structure, often with moderate clayskins. The clay may have fragments of soft weathering argillite which increase in frequency with depth. The clay horizon grades into weathering rock usually between 50-100 cm depth.

The deeper soils have a more markedly red-yellow podzolic morphology. The topsoil grades into a brownish or yellowish upper subsoil of clay loam-clay texture, blocky structure with moderate clayskins, and firm consistence; grading into a redder lower subsoil with more clay, more pronounced and often coarser blocky structure, and stronger and more continuous clayskins. It often contains fragments of soft weathering argillite which increase with depth. The subsoil grades into weathering argillite, normally at depths of 70-150 cm, although there are a few deeper profiles.

In all of these soils the subsoil consistence is firm but rarely compact, and they rarely have the fragic tendencies of the granitic soils. Currasow Subsuite soils are leached, acid and base-deficient. Aluminium is usually the dominant exchangeable cation in the subsoil. Organic carbon and total nitrogen levels in the topsoil are moderate. Phosphate levels, both available and total, tend to be moderate-low.

The soils are under forest in the project area. They are not as erodible as their granitic analogues, i.e. Canada Hill Subsuite, but can nevertheless gully on steep slopes. For the soils of the steeper slopes, above about 15°, all forms of development should therefore be excluded and the land should be left under protective forest. On gentler slopes tree crops are preferred to arable cultivations. Crop management should emphasize the maintenance of complete cover and the avoidance of bare soil.

Apart from erodibility the limitations of these soils are mainly access, nutrient deficiencies and imbalances. The soils need intensive liming and fertilization. There are sufficient free iron sesquioxides in the clay fraction to produce a substantial phosphate fixation capacity. There may also be some moisture deficiencies for the more susceptible crops on the shallower soils. Citrus, pasture and cacao (on the deeper soils) are probably the most suitable cropping systems, as can be seen in Table A2.3, but access will limit development in the foreseeable future.

Pippen Subsuite

The Pippen Subsuite contains the deeper residual soils of coarse and medium texture, mainly derived from the arenaceous metasediments such as quartzite. They occur on gentler slopes than the shallower soils of the Cabbage Haul Subsuite, although they were found on gradients as steep as 25° in Stann Creek District. They tend to occur in concave positions on mid and lower slopes, but are also found on some stable ridge crest sites. Their extent in the project area is unknown but they are thought to be fairly unimportant. The natural vegetation is moderate semi-deciduous broadleaf forest, but there are isolated patches of pine and tiger bush scrub, especially on ridge crests prone to lightning strikes.

There is a considerable morphological range within this subsuite. Soils derived from very siliceous quantities are coarse textured, weakly structured and pale-coloured. They have grey sandy or loamy sand topsoils with single grain or very weak crumb structures. The subsoil is a light grey-yellow loamy sand or sandy loam, whose structure is weak blocky, again tending to crumble to single grain. It is often stony, and overlies hard quartzite at depths between 50-150 cm, usually at the shallower end of the range.

Soils derived from more feldspathic sandstones are redder, medium-textured and more strongly structured. The subsoil texture may be as fine as sandy clay loam, and the moderate blocky subsoil structures have moderate discontinuous clayskins. The lower subsoil may be rather stony and passes into weathering sandstone at depths between 50 and 150 cm. This tends to be rather softer than the quartzite under the greyer and sandier soils.

All of these soils are leached, acid and very base-deficient. They also tend to be low in organic carbon, total nitrogen and all forms of phosphate.

In the project area these soils are under forest. They are not as erodible as their granitic equivalents but they can wash and gully on steep slopes. It is therefore recommended that all of these soils on slopes steeper than 15° should be left under protective forest.

The remaining patches of soils on gentler slopes have difficult access and low agricultural potential. They tend to be droughty because of their coarse textures. They have marked acidity and nutrient constraints and need liming and fertilizers. If they are to be developed, tree crops are preferred, with care given to soil conservation, maintenance of complete cover and avoidance of bare soil, even on the gentler slopes. Because of the costly inputs needed, these soils would be best developed for commercial enterprises. Subsistence milpa and smallholding tree crop farmers are unlikely to thrive and should be discouraged.

Dancing Pool Subsuite

The Dancing Pool Subsuite includes the deep hillwash soils found in concave lower slope sites and along streams, at low and intermediate altitudes. They mostly occur on slopes shallower than 15°, but noted (on steeper gradients) (in Stann Creek District) . They were not seen in the course of this survey, but are almost certainly present as numerous small patches of limited total extent within the project area. Their natural vegetation is semi-deciduous broadleaf forest, which can attain considerable stature in places.

They have varied morphologies reflecting the course of previous and current hillwash deposition. The depth of soil is usually more than 1.5 m, the colour tends to be red and yellow, possibly with grey mottling at depth. Texture tends to be variable with depth, with mixed and randomly orientated stones throughout the profile. Some of the more arable soils have well developed, darkened topsoils with a pronounced crumb structure. Recently deposited soils have not yet developed a melanized topsoil. As noted, textures vary but tend to be medium and fine, infrequent and thin sandy layers. Consistencies are mostly friable – slightly firm. No compact or fragic subsoils have been seen in the soils which are mostly well drained although there may be some impedance in the lower subsoils of profiles close to streams. Most of the soils are well leached, acid and base deficient.

The soils are mostly under forest at present. Those on slopes steeper than 15° should remain under forest. The soils on gentler slopes have good physical properties for crop production, as they combine deep rooting zones, mostly free drainage and good available water capacity. The main constraints are access, acidity and nutrient deficiencies. The soils will need liming and fertilizers to be productive, but have been rated as highly or moderately suitable for a range of tree crops, (Table A2.3).

Granodoro Subsuite

The Granodoro Subsuite contains shallow and moderately deep fine- and medium-textured residual soils formed on the metasediments of the Grano d'Oro – San Pastor Hills, part of which are referred to as the 'Little Pine Ridge' by Wright *et al.* (1959). Scattered patches and boulders of the original overlying Cretaceous limestone (see 'Geology' section) still remain and affect the local soil formation. The soils of the Granodoro Subsuite are formed in apparently non-calcareous parent materials and conditions. They occur on most of the western parts of the hills, in a range of topographic positions, but mostly on moderate or gentle slopes. The natural vegetation is low, stunted semi-deciduous broadleaf forest, which may contain occasional pine (*Pinus caribaea*) trees and has a significant proportion of rosewood. Whenever a clearing occurs, dumb cane flourishes and persists. There are also patches of open canopy with cutting grass ground cover.

The profile morphologies vary considerably according to the proportions of argillaceous and arenaceous metasediments in the parent material. Common features include shallow depths to weathering rock, brown and yellow matrix colours, and a tendency to grey and red mottling in the lower subsoil. Profile OZ 8 (see Appendix 3) is one of these soils developed entirely from argillite. Apart from a few centimetres of silty clay loam at the surface it is clay throughout its shallow depth to the weathering rock at just under 50 cm. The topsoil has a compound structure of fine blocky breaking to crumb. The subsoil is angular blocky with moderate clayskins on the faces.

Profile OZ 87 is an example of a soil developed in mixed parent materials with a subhorizontal band of sandstone giving rise to brown and grey loamy sand and sandy loam horizons, whereas the underlying gritty clay is derived from an argillite bed. A feature of both of these profiles is the horizontal bedding and low degree of fracturing of the underlying argillite, which may partly account for the apparently imperfect drainage, even on sloping sites. The extent to which this is a general feature in these soils is unknown.

The soils are chemically variable. Where entirely derived from metasediments they are acid and base-deficient, but calcareous influences, either from limestone clasts or the water draining from them, can raise the pH and base status. Organic carbon and total nitrogen contents are quite high in some soils (e.g. Profile OZ 86). Phosphate levels are variable but are thought to be generally low.

The soils appear to have formed by *in situ* weathering of the underlying rock. There has undoubtedly been some hillwash but this appears to have been mainly deposited on adjacent limestone to form the soils of the Machiquila Subsuite.

The taxonomic status of these soils and their separation at subsuite level is debatable. They could be incorporated into the Cabbage Haul Subsuite as a intermediate altitude fine textured variant. Equally they could be regarded as part of the shallow high altitude soils of the Chiquibul Subsuite. The classification status requires further work, and they are best retained as a separate subsuite until then.

The soils may be the equivalents of the Mico Series in the Marie Suite (Charter, 1941) which is an argillite-derived soil with minor calcareous influences. In the absence of any limestone effects, they are closer to the Vaca and Macaroni series in the same suite.

The Granodoro soils of Wright *et al.* (1959) are formed in a range of parent materials but some of them (Sets 51, 51H, 51a, 51aH) appear to correlate with the sandier variants of our more narrowly defined Granodoro Subsuite.

In the international systems, the main diagnostic criteria are the shallowness and moderate development. Most of them qualify as Dystric Cambisols (FAO/UNESCO) and Dystropepts (USDA). A few of the deeper soils qualify as Haplic Acrisols (FAO/UNESCO) and Hapludults (USDA).

The definition of the morphological differences between these soils and those of other subsuites in not clear, as already noted. There is considerable morphological overlap with the fine- and medium-textured soils in the Cabbage Haul Subsuite, and the soils of the Chiquibul Subsuite. The difference are mainly geographical and ecological: the stunted rosewood-rich Broken Ridge forest and intermediate altitude of this subsuite are different from the broadleaf forest or tiger bush scrub and low altitudes of the Cabbage Haul Subsuite; and the Mountain Pine Ridge vegetation and higher altitudes of the Chiquibul Subsuite. Granodoro soils are shallower than the Machiquila Subsuite soils and do not overlie.

If it is ever required to map these soils in detail, the best criteria for subdivision into series are texture and depth.

These soils are completely uncultivated, although there are patches of what appears to be old wamil. The forest contains poor quality primary timbers such as mahogany and cedar, but does contain some santa marias and other secondary species. It is currently exploited on a modest scale for rosewood, not for board or log timber, but for burls for ornamental carving .

The agricultural limitations are mainly physical. The combination of slightly impeded drainage in wet weather, and shallow rooting zones in dry weather imposes alternating aeration and moisture stresses on vegetation. The soils without any limestone influences are also acid and base-deficient. They will require liming and fertilization for productive agriculture. This combination of constraints limits agricultural potential, as can be seen in Table A2.3. For the present, they are best left under protective or low intensity productive forests.

Machiquila Subsuite

Machiquila Subsuite soils are deep, reddish and of medium and fine textures in Santa Rosa metasedimentary hillwash overlying limestone. They are found in flat and gently sloping basins to the south of the Grano de Oro-San Pastor Hills. The hillwash is derived from these and other local metasedimentary hilly inliers protruding through the limestone. Their extent is unknown but is probably restricted in importance. Their natural vegetation is semi-deciduous broadleaf forest of variable stature and composition. The forest around Profile OZ 88 (see Appendix 3) is low Broken Ridge. Other areas appear to support high forest, which has been exploited for mahogany and cedar.

As in many hillwash soils the morphologies appear to be variable, although only a few profiles were seen. Profile OZ 88 is an example in which the hillwash is predominantly fine-textured, derived mainly from argillites. Beneath a yellowish brown silty topsoil, the rest of the profile is clay, which is red or pink to about 50 cm but becomes yellower below that. Structures are moderate and strong blocky in the upper horizons but become weaker with depth, with a tendency to platiness at a depth of 50-100 cm. The subsoil consistence is firm but not compact or fragic. The limestone was encountered at a depth of 160 cm in this profile but is often shallower than this. As is often found where siliceous material overlies limestone, the horizon just above the contact contains many black ferrimanganiferous concretions, mostly soft in Profile OZ 88, but hard rounded concretions can also occur. Where the hillwash is derived wholly or partly from arenaceous metasediments, the soils are coarse- and medium-textured, but the pale red and brown colours, weak subsoil structures and range of depths are similar.

Acidification of these soils by leaching is countered by the biological uptake and recycling of calcium from the underlying limestone. Base status is therefore higher than in the other soils of this suite (e.g. Profile OZ 88, especially in the subsoil). Organic carbon and total nitrogen levels are moderate, as are available and total phosphate.

The assignment of these soils to the Ossory Suite assumes the siliceous hillwash is more important than the underlying limestone, as in deep soils such as Profile OZ 88. The minimum hillwash depth to justify this assumption is probably about 50-60 cm. Profiles shallower than this are really limestone soils with siliceous surface contamination. No such soils were seen and no provision has yet been made for them in Chacalte or other limestone suites, but this may be necessary in the future.

The San Pastor Series in the Chiquibul Suite of Charter (1941) is described as a deep clay derived from argillite overlying limestone boulders. It therefore resembles the finer textured soils of our Machiquila Subsuite, including the occurrence of ferruginous concretions in some profiles. The Machiquila sets of Wright *et al.* (1959) have coarse-textured topsoils, but their subsoils are similar to those in this study's soils of the same name. However, there is no mention of underlying limestone.

In the international systems the textural differentiation appear sufficiently developed for the soils to qualify for groups defined by the presence of an argillic horizon. In the FAO/UNESCO classification they are Chromic Luvisols. In the USDA Soil Taxonomy they are Kandudalfs or Kanhapudales. Where argillic horizons are less developed, the soils would probably be called Eutric Cambisols (FAO/UNESCO) and Eutropepts (USDA).

The morphologically closest and most easily confused soils are those of the Quamina Subsuite in the Melinda Suite, which have siliceous alluvium overlying limestone. However, their siliceous material has been transported by river action over considerable distances and they show distinctly alluvial features such as textural stratification and high silt and mica contents. They are also lowland soils, and tend to occur along the lower stretches of substantial streams and rivers.

If the area around the Chiquibul Valley is developed for agriculture in the future, more detailed surveys of these soils will be necessary. The best criteria for subdivision into series are texture and depth to limestone. Subsoil colours and indications of impeded drainage may also be useful.

The soils are currently under forest, some of which appears to be secondary, and may be very old wamil, suggesting previous agricultural use. However, the main production from these soils in this century appears to have been timber and chicle.

The morphological and chemical characteristics of these soils indicate they should be quite productive. Physically they combine potentially deep rooting, high available water capacity and apparently free drainage. Chemically, the effect of limestone is to reduce base deficiencies, although the upper horizons are still quite acid. The crop suitability ratings in Table A2.3 have been downgraded, however, because of the occurrance of patches of natural Broken Ridge vegetation, thought to indicate poor growing conditions, possibly due to poor drainage or low nutrient status.

Cooma Subsuite

Cooma Subsuite includes the deeper and more developed soils derived from the metasediments in the Mountain Pine Plateau. They are intermixed with the shallower and less developed soils of Chiquibul Subsuite. As the metasediments are more resistant to weathering and erosion than the granites they have formed the higher ground of the dissected plateau (metasedimentary valleys subunit). They occupy the great eastern horseshoe of high land that runs round from the Cooma Road to the Brunton Trail, partially enclosing the central and western basins of lower granitic terrain. There is also a considerable area of these soils on the relatively subdued terrain over argillites in the eastern part of the Grano de Oro-San Pastor Hills, sometimes referred to as the 'San Pastor Pine Ridge' or 'Little Pine Ridge'.

The soils occupy a great range of topographic positions in the Mountain Pine Ridge ranging from relatively undissected plateau remnants to steep lower slopes. The vegetation is Mountain Pine Ridge tree savanna. The main species of pine on the steeper slopes is *Pinus patula* (*tecunumanii*) (formerly *P. oocarpa*). On some of the older and more leached soils on stable plateau remnant sites, *P. caribaea* is dominant. Other trees include crabboo, oakes and some *Micronia* sp. *Hypericum* sp. is a common shrub. The ground cover consists of a range of pine ridge grasses such as *Trachypogon* spp.. When disturbed these soils are often invaded by dumb cane and tiger bush. The dumb cane is very dense on these soils in the 'Little Pine Ridge' at San Pastor.

Because of the variability of the metasediments there is a considerable range of soils, but argillites appear to predominate, and most soils are fine-textured. The soil surface often has a fairly thick pine needle litter layer, sometimes with quartz and argillite stones. The topsoil is brown to dark brown silty or fine sandy loam-clay loam. It has a moderate simple crumb structure or a compound structure in which moderate fine blocky breaks to crumb. It is generally friable, and usually more or less free of stones.

This contrasts with the underlying horizon which is usually a thick stone layer. The main stones are angular quartz and red-brown-black iron and manganese-coated fragments of red, grey and purple slightly weathered argillite. The quartz and argillitic stones are sometimes intermixed, but may be segregated and stratified in some profiles (e.g. Profile OZ 42). The interstitial fine earth is red-brown silty clay loam-clay. The structure is dominated by the stones, which also contribute to the overall compact consistence, although the fine earth is no more than firm. Even where there is more than 20 cm of apparently densely packed stones, this layer does not appear to prevent root penetration.

Beneath the stone line there is a horizon of red-reddish yellow silty clay -clay. This has a markedly lower stone content than the horizon above, but contains fragments of weathered argillite, which increase in frequency with depth. They are often coated with ferrimanganiferous deposits. The fine earth has a moderate blocky structure, often with moderate clay coatings on the ped faces, and slightly firm-firm consistence. It grades into weathering argillite of variegated red, yellow, purple, grey and other colours at depths ranging from 50-150 cm, usually at the shallower end of the range. The argillite appears to be weathered and rubefied to considerable depth. The soil appears to be well drained, particularly where the underlying rock strata are steeply or vertically bedded. There are coarser textured soils in this subsuite for which quartzite and sandstone are important components of the parent material. However, they are not common because the more arenaceous rocks give rise to shallower soils, most of which qualify for Chiquibul rather than Cooma Subsuite.

These are acid soils, with pH in water ≃<5. Base saturations are low, often less than 20%. Organic carbon and total nitrogen contents are moderate. Phosphate levels, both available and total are low. The granulometric analysis of Profile OZ 42 confirm the high silt contents of these soils.

The soils appear to be mostly derived from *in situ* weathering of argillites; but the stone layer suggests that colluviation has occurred, although it and the relatively stone-free topsoil could have been formed by selective excavation of the fine earth by soil fauna.

The grouping of all of the deeper Mountain Pine Plateau soils from metasediments means the subsuite is rather heterogeneous, but the broad subdivision of the Mountain Pine Plateau into granitic (Pinol) and metasedimentary soils is useful on ecological and silvicultural grounds.

Cooma soils may be equivalent to some of the Challilo, Silkgrass and possibly Canada series in the Croja Suite of Charter (1941). They also correlate with Wright *et al.*'s (1959) finer textured Pinol sets (i.e. 52a, 52aH, 52b, 52bH, 52c and 52cH). Birchall's (1973) Pinol sandy clay loam is also similar to the Cooma soils of this study.

In the international systems the soils generally show sufficient textural stratification to qualify as Plinthic Acrisols (FAO/UNESCO and Plinthudults (USDA), but some of them are probably only Dystric or Plinthic Cambisols (FAO/UNESCO) and Dystropepts (USDA).

The distinction of these soils from those of other subsuites is not wholly straightforward. The boundary with the shallower and less developed but otherwise similar soils of the Chiquibul Subsuite is gradational, with the division at about 50 cm to weathered rock. The soils of the Pinol Subsuite are clearly distinguished on the basis of their weathering granite and abundant angular quartz grit.

Whilst these soils remain under extensive pine forestry, there is little need for detailed survey and subdivision into series. However, if ecological or silvicultural field experiments require a finer subdivision, the obvious criteria for series definitions are the thickness and density of the stone layers, texture, and depth to weathering argillite, although the last is diffucult to determine in a profile pit, let alone in augering.

The soils are currently almost entirely used for pine forestry. The aim is that the forests regenerate naturally, with no need for planting. Growth is slow and rotation times are long (40-70 years) (Johnson and Chaffey, 1973a).

The soils have severe agricultural contraints, because they are rather shallow and droughty due to the high stone content in fine earth. Acidity, dominance of the solution and exchange complex by aluminium, and deficiencies of basic cations, phosphate and other nutrients make the soils chemically infertile. The best are rated no more than moderately suitable for pasture and possbily marginal for citrus and vegetables. They are assessed as unsuitable for all other crops (Table A2.3). It is recommended the soils remain under pine forestry.

Chiquibul Subsuite

The soils of the Chiquibul Subsuite are the shallower and less developed soils derived from argillite at high altitudes. They are common in the Mountain Pine Plateau, intermixed with the soils of the Cooma Subsuite. They are also thought to occur on argillites in other parts of the Maya Mountains. They tend to occur on steep and erodible slopes, often downslope from the Cooma soils that persist on the less dissected plateau remnants. In the Mountain Pine Plateau, they are largely under *Pinus patula* (*tecunumanii*) (formerly *P. oocarpa*) tree savanna. Other trees are crabboo and oak. *Hypericum* sp. shrubs can form clumps in the undergrowth, and pine ridge grasses such as *Trachypogon* spp, form the ground cover. When the pine savanna is disturbed it is often invaded by dumb cane and tiger bush.

The parent materials include more quartzite than those of the deeper soils of the Cooma Subsuite; and there is therefore a great textural range. The topsoil is dark coloured, crumb or compound fine blocky structured, and friable. It can range in texture from sandy loam to clay loam. It grades into a reddish or yellowish subsoil which is finer-textured, more blockily structured the faces of which are virtually devoid of clay coatings and firmer than topsoil. The subsoil contains common fragments of quartzite and/or argillite, which may have black ferrimanganiferous coatings; and grades into weathered rock at depths of 30-50 cm. The underlying rock tends to be harder than that under Cooma soils.

Despite their relative immaturity, the soils are leached, acid and base-deficient. Organic carbon and total nitrogen levels are moderate. In Profile OZ 39, available phosphate levels are also low but the total content of phosphate is moderate.

The soils have formed by *in situ* weathering of the metasediments. The shallowness and lack of textural segregation and clayskins indicate immaturity, considered to be due to continual profile truncation by hillwash on the steep slopes.

The reason why the metasedimentary but not granitic soils are subdivided on the basis of depth is that shallow soils are more common on the steeper slopes produced by the resistant metasedimentary rocks, than in the generally more gentle terrain produced by the grantic rocks.

These soils appear to be the same as some of the shallower soils in Dry Creek, Chalillo and possibly Canada series of Charter (1941). There is a Chiquibul Set of soils in Wright *et al.* (1959) but our Chiquibul Subsuite correlates well only with the shallower members (i.e. sets 39H and 39aH on argillite and quartzite respectively). None of Birchall's (1973) profiles on metasediments is shallow enough to correspond to these soils.

In the international systems the main diagnostic features of these soils are their shallowness and lack of development. They qualify as Dystric or Lithic Leptosols, or Dystric or Chromic Cambosols (FAO/UNESCO) and Lithic Dystropepts (USDA).

At present these soils in the Mountain Pine Plateau are all used for pine production. As in the stands on Cooma soils, growth tends to be slow and rotations long. The agricultural constraints are considerable. The steep slopes make them vulnerable to erosion. The shallowness and stoniness makes them droughty, and the acidity and low base status lead to deficiencies and imbalances in the supply of nutrients. These limitations combine to give these soils low crop suitability assessments, as shown in Table A2.3. These soils should remain under Mountain Pine Ridge savanna. When they are logged, attention to soil and environmental conservation is necessary, especially if they are clear felled.

Baldy Subsuite

The prismatic stony clays of the Baldy Subsuite are the main soils of the Bald Hills, the eastern end and highest part of the Mountain Pine Plateau. They occupy a wide range of topographical positions: from the rounded hill tops to the steep middle slopes. The lower slopes of the steeply dissected terrain tend to be occupied by shallower soils of the Chiquibul Subsuite. The natural vegetation is Mountain Pine Ridge grass savanna, with scattered and stunted pine (*Pinus caribaea*) and crabboo trees and wide swathes of grass cover of mainly *Trachypogon* spp. but the shaving brush sedge is also common.

The surface of these soils is very stony, almost forming a pavement in places, with the grass sprouting through the cracks. Most of the stones are subangular and angular quartz, ranging up to 10 cm across. This surface overlies a grey or greyish brown topsoil of stony loam texture and weak interstitial crumb structure. The underlying subsoil is also stony, with silty loam-clay fine earth textures, grey and pale yellow colours and coarse blocky structures. This subsoil becomes less stony with depth and the texture is silty clay-clay. A characteristic feature of these soils is the tendency for the pale clay subsoils to form marked coarse prismatic structures, which are very pronounced in road cuttings. They are compound structures and break to medium or coarse blocky. The prisms have moderate continuous clay coatings, especially on the vertical faces. Stone frequency increases with depth, and the horizon grades into weathering argillite at a depth of 50-100 cm.

The soils of the Baldy Subsuite are very leached, acid and base-deficient. Organic matter levels, including nitrogen, are quite high in the topsoil, but decrease rapidly with depth. Available phosphate is nearly zero and total contents are low. Total calcium contents are extremely low. The increasing clay content with depth is confirmed by the granulometric analyses, but Profile OZ 43 shows that silt is important.

The soils are formed by weathering of the underlying argillites, but there is also evidence of wash and creep processes, e.g. the marked residual stone pavements and the altiplanation terraces (Figure 27) that are prominent features of some of the gently to moderately sloping graded convex upper and middle slopes.

Baldy Subsuite soils appear to correlate with:

(1) Part of Charter's (1941) Dry Creek Suite, especially the Dry Creek Series;

(2) Some of the schist and quartzite soil briefly described by Darcel (1952a and b);

(3) Wright *et al.*'s (1959) Baldy Soils (sets 70 and 70a).

In the international systems the increase in clay content and ped coatings with depth probably qualify the subsoils as argillic horizons. The soils therefore qualify as Haplic or possibly Humic Acrisols, with a few having high enough cation exchange capacities to be Alisols (FAO/UNESCO) and Kandiudults or Hapludults (USDA). Some shallower and less horizonated soils are probably Dystric or Humic Cambisols (FAO/UNESCO) and Dystropepts or Humitropepts (USDA).

Baldy Subsuite soils can be easily distinguished from the Cooma Subsuite soils at lower altitudes by their paler colours and more prismatic subsoil structures. The occurrence of a surface stone pavement compared with the subsurface stone layer in the Cooma Subsuite is another distinguishing feature. Excavating activities of soil fauna at lower altitudes appear to have buried the stones in the Cooma Subsuite. This is another aspect of the different edaphic and ecological relationships of the two soils, which also shows in the contrasting vegetation. The boundary with the less developed and shallower Chiquibul soils is gradational: a depth of about 50 cm to unequivocal weathering rock appears to be a reasonable division.

Little need for detailed surveys or subdivision into series is foreseen. If it should be necessary, texture, depth, and degrees of development of the stone pavement and the prismatic subsoil structures are likely to be useful criteria.

Most of these soils are in the Mountain Pine Ridge Forest Reserve, but the sparse and stunted trees are not a potential source of timber. Most of the accessible area is used for military training, including live artillery fire and aerial ground attack.

The stoniness and shallowness of these soils make them rather droughty, especially considering the frequency of the drying breezes and winds of their exposed position. The acidity, low base status and other nutrient deficiencies and inbalances makes them chemically infertile. These constraints combine to produce a low overall potential agricultural productivity, as indicated by the crop suitability ratings in Table A2.3, in which only pasture is considered marginally suitable in places.

These soils should not be considered for agriculture or production foresty. The Bald Hills form an unusual and attractive landscape and have some tourist and recreational potential, were it not for the military presence.

RICHARDSON SUITE

The Richardson Suite includes all soils developed on the rocks of the Bladen volcanic member of the Santa Rosa Group (Bateson and Hall, 1977). The soils occur on and astride the western section of the main divide of the Maya Mountains. Ground access to these areas is difficult, especially now that the chicleiro trails into and across the mountains are not used. The soils were seen only in a limited area around the highest point on the divide, which is also the highest point in the country. Access for our fieldwork was by helicopter, by courtesy of the British Forces, Belize, who together with the Belize Audubon Society and the Belize Zoo mounted a multidisciplinary ecological study of the area.

The Bladen volcanics, many of which have distinctly porphyritic texture, range in composition from andesite to rhyolite. Many are breccias, which may enhance water penetration and hence rates of weathering.

Only three subsuites have been separated at this stage. As more data becomes available, others will probably be defined. The three so far are:

(i) Palmasito — Deep red and yellow soils of ridge crests and slopes;

(ii) Doyle — Similar to Palmasito but with podzolic features in the surface horizons;

(iii) Ramos — Shallow red and yellow soils on very steep slopes.

Palmasito Subsuite

The Palmasito Subsuite soils are the most common in the area studied. They occupy the ridge crests and the steep and long slopes of the main Maya Mountain divide and its spurs. For such deep soils they occur on surprisingly steep slopes, well over 30° in places. The natural vegetation is semi-evergreen broadleaf forest of very high stature and biomass, and are some of the most impressive-looking forests in the country. The forests on the ridge crests are characterized by the high frequency of the very tall (40-50 m) endemic palm *Colpothrinax cookii*. There are also many *Euterpes* spp. palms. The subsuite is named after this domination by palms. The main broadleaf species are santa maria and figs of *Clusia* spp. The palms are less prominent on the slopes, which support many large santa maria and have rather sparse ground cover.

The soils included in this subsuite are morphologically quite variable, due to the heterogenity of the parent material, and the vagaries of hillwash and creep. The commonest profile form seen was the deep red and yellow loam, as exemplified in Profile OZ 28 (see Appendix 3). The surface has a moderately deep (3-10 cm) fibrous and sapric litter layer, well-rooted with many apparently mycorrhizal blunt roots and white hyphae. The mineral topsoil is reddish brown-brown sandy or gritty clay loam. It tends to have a blocky structure breaking to a fine crumb. Consistence is generally friable. There may be fine fragments of metaandesite. The topsoil grades into a merging sequence of subsoil horizons, which often extend to well over a metre, even on steep slopes. They are red-reddish yellow in colour, with partial weakening mottles coming in only at depth, close to the paralithic contact. The structures are weak blocky, easily breaking to crumb. There may be weak and discontinuous clay coatings in the lower subsoil. Textures vary from loam to clay, with clay loam the most common. The soils remain friable in the hand for the full depth of the solum. However, *in situ* there is a slightly 'crisp' feel, which possibly indicates the very early stages of a fragic consistence. The boundary to the soft underlying weathering metaandesite is clear.

Whereas most soil profiles have a finer texture and more crumb-like structures in the topsoils than in the more coarsely blocky subsoils, in some of these soils, the most pronounced blocky structures are in the surface layers, and the structures of the subsoil are less clearly expressed and crumble to fine blocky or crumb peds (e.g. Profile OZ 29). Stone lines of metaandesite or metarhyolite due to colluvial layering are found in some of these structure-inverted soils

Palmasito soils are very leached and acid, with pH in water <5 and sometimes <4. The exchangeable base status is very low, with base saturation percentages in low single figures in some subsoils, partly due to the high cation exchange capacities (e.g. Profile OZ 28). Organic matter and nitrogen levels are moderately high and persist well into the subsoil. Available phosphates are low and total phosphates moderately low. The granulometric analyses confirm there is no significant and systematic increase in clay content with depth.

These soils form by rapid weathering of the underlying andesite, due to the susceptibility of the parent material and the intense leaching. The layering in some slope soils indicates considerable slope movement but the generally deep soils show that the rate of erosion is not rapid. The relative stability of these soils is attributed to their excellent infiltration and drainage properties. The litter layer and high organic matter contents combine to give high infiltration capacity at the soil surface. The crumb structures, bright reddish colours and absence of mottles indicate permeable subsoils. The rate of water acceptance and vertical transfer is therefore potentially high, tending to decrease overland flow and surface wash.

Wright *et al.* (1959) is the only previous study that included these soils but, without the advantage of helicopter access, their field data were limited. Our Palmasito soils fall in their Richardson Peak soils (Set 68). Their Palmasito soils (Sets 43, 43a, and 43aH) may also include some of these soils, although they are mostly over metasediments.

In the international systems Palmasito soils appear to lack the andic properties characteristic of young soils on volcanic parent materials (Andosols in the FAO/UNESCO Legend and Andisols in the current version of the USDA Soil Taxonomy. The soils have weathered sufficiently that the crumb structure and friability and unimportance of argilluviation probably qualify the subsoils as ferralic B or oxic horizons, except that some cation exchange capacity/clay ratios are rather high – possibly an andic inheritance. Palmasito soils are therefore Haplic or Humic Ferralsols (FAO/UNESCO) and Hapludox (USDA). In some profiles there may be sufficient textural segregation for the soil to qualify as a Haplic Acrisol or

Alisol (depending on low and high cation exchange capacities respectively) in the FAO system, and Hapludults in the USDA Soil Taxonomy.

The Palmasito Subsuite is distinguished from the Doyle Subsuite by the absence of micropodzolic features. The Palmasito Subsuite grades into the shallower Ramos Subsuite. A depth of about 50 cm to weathering rock seems to be a reasonable dividing line.

Palmasito soils are not extensive, and occupy inaccessible and steep terrain. Detailed pre-development surveys are unlikely, and the necessity for subdivision into soil series is therefore also unlikely. If the need should arise, depth and texture are likely to be the most useful series criteria.

Palmasito soils are under undisturbed forest, with no signs of logging, chicle gathering, old milpas or even hunting trails in the area around the highest point.

The main limitation for any form of exploitation is the generally very steep gradients. Severe erosion is likely if the forest is disturbed. For the few sites with shallow slopes, the limitations for agriculture appear to be entirely chemical. Physically, the soils have an excellent combination of depth, high available capacity, easy root penetratability and free drainage. However, they suffer from acidity, excessive alumination, and severe nutrient deficiencies and imbalances. Production would probably depend on heavy and carefully managed liming and fertilization. The combination of erosion hazard and nutrient constraints is reflected in the low ratings for these soils in Table A2.3.

We strongly recommend that these soils should stay under protective forest. Even logging is likely to cause erosion and environmental degradation elsewhere that will cost more than the benefits from timber yields.

Doyle Subsuite

The Doyle Subsuite consists of volcanic soils with micropodzolic features, occurring in very limited areas on the highest ridges of the main divide of the Maya Mountains. They were seen on the ridge up to the highest point in the country. They occupy ridge crests and gently graded convex upper slopes. They are not found on the steeper gradients, even short distances downslope. They carry semi-evergreen broadleaf forest with a high proportion of palms, especially *Colprothrinax cookii* and *Euterpe* spp.

The profile consists of a shallow podzol superimposed on a Palmasito-type ferralic or oxic profile. The surface has a mor litter layer, up to 15 cm thick in places but only 6 cm thick in Profile OZ 26 (see Appendix 3). The mineral topsoil is black and very humic, giving it a very silty feel. It overlies a thin greyish horizon, which in Profile OZ 26 has a silty clay texture and weak structure. The greyish horizon overlies a thin distinctly darker horizon, which in Profile OZ 26 grades into a thin reddish brown horizon, of similar texture. These four horizons, whose total thickness is less than 30 cm, are regarded as a shallow podzol with the following horizons (using the conventional notation): Ao, litter; Ae, eluvial; Bh, humic illuvial; and Bs, sesquioxide illuvial.

Beneath this sequence, the profile is a red and yellowish deeply weathered soil. The main subsoil horizon in Profile OZ 26 is brownish yellow silty clay with a moderate medium subangular blocky structure. There are clay coatings on some ped faces but they are weak and discontinuous. This horizon grades into weathering andesite at over 1.5 m depth.

This soil is extremely leached and acid, with pH in water <4 except in the lower subsoil. Base saturation percentages are extremely low, partly due to the high cation exchange capacities. The upper horizons are dominated by high contents of exchangeable aluminium. The mineral topsoil has a high organic carbon content, which is considerably lower in the Ae horizon and rises in the Bh. It falls again but even the deep subsoil horizons have moderate carbon and nitrogen contents. Available phosphate levels are very low, although total prosphate contents are moderate. The granulometric analyses confirm the field indications that clay movement is relatively unimportant.

The bulk of the profile appears to be formed by deep and rapid weathering, induced by intense leaching. The sequence of thin horizons at the surface appears to be due to subsequent podzolization. An alternative explanation is that the dark and higher organic carbon subsoil horizon (at a depth of 15-20 cm in Profile OZ 26) is a buried topsoil. The podzolic origin is more plausible because of the occurrence of the paler Ae and redder Bs horizons above and below the dark horizon respectively. The fact that these soils are restricted to the more stable ridge crests and more gently graded upper slope sites also corroborates vertical segregation rather than horizontal wash as the more likely mechanism. The considerable depths of these soils are due to the relatively stable sites.

There is no mention of these micropodzolized soils in earlier studies and surveys in Belize.

Their placement in the international systems is determined by the nature of the deep weathered subsoil. As in the Palmasito Subsuite, this appears to be sufficiently weathered to be ferralic or oxic rather than andic, although cation exchange capacities are high. The small increase in clay content with depth and weakness of the subsoil clay coatings suggest there is no convincing argic horizon. These soils are therefore probably Humic Ferralsols (FAO/UNESCO) and Acrudox or possibly Sombriudox (USDA). Where clay increases are sufficient, they may qualify as Humic Alisols or Acrisols (FAO/UNESCO) and Kandiudults or Paleudults (USDA).

The soils are distinguished from those of Palmasito Subsuite by the micropodzolic features in the surface horizons. The boundary is gradational and Profile OZ 27 is an example of a Palmasito soil on a ridge crest that shows faint traces of incipient podzolization, especially in the dark brown horizon at a depth of 4-10 cm. Doyle Subsuite is distinguished from Ramos Subsuite by depth of the solum and the occurrence of micropodzolic features. There are no other soils so far seen that are likely to be confused with those of the Doyle Subsuite. Doyle Subsuite soils cover a small area that merits conserving on ecological and environmental grounds. The soils are unlikely to need detailed surveys for agricultural development, but subdivision for ecological studies may be necessary. The degree of podzolization, textures of the reddish subsoil and depth to weathering parent material will probably be the most useful criteria for differentiation into soil series.

The soils are under undisturbed forest. They have a physically good agricultural potential, with a combination of deep and easily penetrable soil, high available moisture capacity and free drainage. Chemically, they impose severe nutrient constraints. The acidity, dominance by aluminium and multiple nutrient deciciencies and imbalances mean these soils would require heavy and carefully managed liming and fertilization to be agriculturally productive, as indicated in the assessment of the suitabilities of these soils in Table A2.3.

Although these soils are mostly on fairly stable sites, they are perched on narrow ridge crests between steep slopes. They are therefore very vulnerable to erosion if injudiciously deforested or otherwise disturbed. In view of their unique environment and limited extent, they and the bordering steep slopes should remain under undisturbed protective forest in perpetuity. Even tourist and recreational activities will need careful control. Military training facilities should be excluded .

Ramos Subsuite

The shallow volcanic soils that develop on very steep slopes comprise the Ramos Subsuite. Few were seen in augerings in the Highest Point area, but they have not been examined in detail in profile pits. Their extent is unknown but may be limited, because of the tendency of the deeper soils of the Palmasito Subsuite to develop even on slopes greater than 30°. The Ramos soils are found on the long steep side slopes of the western section of the main divide of the Maya Mountains. The vegetation is tall semi-evergreen broadleaf forest with a high proportion of santa maria and nargusta. There are fewer tall palms, especially *Colpothrinax cookii* than on the ridge crests.

The profile consists of a brown-yellowish brown topsoil of loam-clay loam texture, weak fine blocky structure, and friable consistence, which grades into red-reddish yellow silty clay, fine sandy clay or clay with a coarser blocky structure, and slightly friable consistence. This lower horizon has fragments of weathering parent material which increase in frequency with depth. The boundary to the underlying weathering rock is gradational at a depth of 30-50 cm. No soils shallower than 30 cm were seen.

The soils were not analysed but they appear to be leached, acid, and have a low exchangeable base status. Organic carbon, total nitrogen and available phosphate levels are probably rather low and total nutrient contents moderate.

The soils are produced by the dynamic balance between rapid weathering of the volcanic parent material and profile truncation by erosion.

The only previous soil study to mention these soils was Wright *et al.* (1959). They mostly correspond to their Richardson Peak Soils (Set 68).

In international systems the deeper soils may qualify as Haplic Andosols (FAO/UNESCO) and Haplic or Lithic Dystridands or Dystrandepts (USDA), but many are insufficiently andic, and are therefore Ferallic or Dystric Cambisols (FAO/UNESCO) and Dystropepts (USDA).

These soils are mostly under undisturbed forest. The overriding limitation on development is the erosion hazard on the very steep slopes. Even if they were on stable sites, there are physical and chemical limitations. The limited depths give a tendency to droughtiness, and there are likely to be severe acidity, aluminium toxicity and nutrient deficiency limitations. This combination of limitations accounts for the low suitability assessments in Table A2.3.

The soils must stay under undisturbed protective and protected forest for ever. Any deforestation, logging or other disturbance is likely to lead to severe erosion. The costs of environmental degradation to downstream and offshore areas would far outweigh any shortlived benefits from timber or agricultural crops.

Table A2.1

Classification and distribution of soils

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
Turneffe	Recent coastal deposits	Shipstern	Raw and weakly developed soils in shallow calcareous sediment over hard coral. Very droughty	31, Auger 380	Coral flats of recently emerged coastlines. Land Systems AI, AN, ZY	Beach forest. Scattered coconuts, pineapples
		Ambergris	Raw and weakly developed soils in deep calcareous beach sediments. Neutral or alkaline. Very droughty	–	Modern beaches and recent strand plains. Land System AB	Beach forest. Coconuts, pineapples, tourism
		Hopkins	Raw and weakly developed soils in deep siliceous sand. Acid, base-deficient and droughty	–	Modern beaches and dunes. Land Systems SB, TB, TY	Beach forest. Coconuts, pineapples
		Matamore	Deep pale siliceous sand with weak horizonation, slight reddening and clay increase. Acid, base-deficient and droughty	(SC25)	Relict inland strand plain. Land System SM	Deciduous broadleaf forest. Now cleared for root crops, cashew, cassava, pineapple
Melinda	River alluvium	Monkey River	Weakly developed brown and grey soils in young siliceous alluvium. Variable textures with layering inherited from alluvium. High silt and fine sand contents. Moderate nutrient fertility. Imperfectly or well-drained	(SC4, SC10, SC24, SC43, SC45, SC46, SC47)	Floodplains and low floodplain benches in young and recent siliceous alluvium. Land Systems CF, MF, SF, BF, IF	Riverine forest. Much used for tree crops, and annual matahambre or milpa crops
		Quamina	Weakly developed brown and grey soils in calcareous alluvium, or siliceous alluvium with calcareous flood or ground waters. Variable textures with layering inherited from alluvium. High base status and nutrient fertility. Imperfectly or well-drained	61, 62, 63, (+SC16, SC17)	Flat alluvial plain and high floodplain benches and terraces of rivers with mixed siliceous catchments. Land Systems BX, CF, VF	High broadleaf forest. Intensively used for tree crops, pasture and matahambre or milpa crops

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
		Pasmore	Layered dark and grey clay and limestone fragments. Calcareous and high base status. Imperfectly or well-drained	–	Limited extent in alluvium of streams in limestone areas. Occasional pockets along main rivers. Land Systems HX, OD, HZ, LK	High broadleaf forest, often with high density of cohunes
		Canquin	Moderately developed reddish silty loam-clay, sometimes with subsoil stone layers. Some clay movement, but also layering inherited from alluvium. Firm–compact subsoils. Acid. Slightly base-deficient. Well–imperfectly drained	(SC5, SC7, SC13, SC51)	High floodplain benches and terraces in middle reaches of major rivers with mainly siliceous catchments. Land Systems CF, BF, MF, VF, HF, BF, IF	High broadleaf forest frequently removed for intensive tree crop (especially citrus) and pasture development
		Sennis	Top 30-100 cm is grey, brown or dark weakly developed alluvial soil of Monkey River, Quamina or Pasmore type, overlying white and red mottled compact sandy clay subsoil of Puletan Suite. Moderate–high base status in topsoil, but acid and base-deficient below. Drainage good–imperfect	82 (SC15, SC49, SC50)	Floodplains of streams and alluvial washes draining out of siliceous hard rock or calcareous catchments and traversing old alluvium of Pine Ridge plains. Subunit 'W' in Land System Type F	Distinctive ribbons of broadleaf 'gallery' forest through expanses of pine forest and savanna. Used occasionally for milpa and currently being tested for permanent tree crops
Puletan	Planosols over deep, acid and old coastal alluvium	Crooked Tree	Very pale-coloured and very coarse-textured weakly podzolized topsoil more than 50 cm deep over mottled red and white acid sandy clay. Deep root zone but droughty and base-deficient	54, 59	Some higher interfluves on coastal plain. Land System KP	Pine tree savanna, often with a dense cover of tall pines and large oaks. Favoured for cashew cultivation. Also used for pasture and extraction of building sand

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
		Boom	Pale-coloured sandy topsil less than 50 cm deep over mottled and compact red and white sandy clay subsoil. Acid. Restricted root depth – droughtiness in dry season. Low subsoil permeability – poor drainage in wet season	13, 14	Widespread in Northern Coastal Plain Pine Ridge areas. May occur downslope of Crooked Tree or over whole interfluves. Land Systems OP, BP	Pine savanna. Trees are smaller and less dense than on Crooked Tree. (Oak trees are noticably less common.) Some pineapples, cassava and cashew are planted
		Bocotora	Similar to Crooked Tree and Boom, but mottled subsoil contains substantial red and dark red soft plinthite and hard ferricrete. Same nutrients, droughtiness and drainage limitations as for Crooked Tree and Boom	83, 84	Upper surfaces in Land System BP	Pine savanna, with local denser patches of pine and oak providing for a varied understory of shrubs. Not much used for agriculture
		Backlanding	Pale-coloured medium-textured topsoil abruptly over red and white mottled compact clay. Acid and base-deficient. Poorly drained in wet season	–	Northern Coastal Plain Pine Ridge areas, especially lower slopes. Land System OP	Pine forest and orchard savanna. Little used for agriculture, apart from extensive rough pastures
		Haciapina	Deep, pale-coloured very wet sandy topsoils over compact red and white mottled clay subsoils. Very poorly drained. Also acid and base-deficient	(SC48)	Lower slopes and drainage line accumulation sites in coastal plain. Land System subunit 'pW'	Pine savanna with minimal tree cover other than clumps of palmetto
		Buttonwood	Distinctively saline throughout. Pale-coloured sandy or medium textured topsoil over mottled red and white sandy clay subsoil, less compact than in most Puletan soils. Saline, base-deficient and poorly drained	(SC41)	Scattered on lower slopes of coastal plain fringing coast or mangrove swamps. Rare in enclosed basins inland. Land System subunit 'sl'	Distinctive variation of Pine Ridge, with high proportion of silver buttonwood. Some areas cleared for shrimp farms

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
Tintal	Wet alluvium and hillwash	Pucte	Seasonal freshwater gleys. Mostly fine-textured but some coarse layers inherited from deposition. Subsoil colours usually pale Gypsum in some lower subsoils. Moderately fertile topsoil. Poorly drained	48, (85)	Lower interfluve slopes. Often occurring as a narrow belt between higher land and major lowland swamps. Subunit 'W' in Land systems ZZ, OZ, OK, BJ. Subunit 'h' in Land Systems OW, NH	Marsh forest, with high proportion of pucte trees and botan palms
		Chucum	Seasonal freshwater gleys. Mostly fine-textured but may have distinctly coarser topsoils. Subsoils often dark-coloured. Gypsum possible throughout subsoil. Infertile and poorly drained	71 (JPL B1)	Enclosed depressions on limestone plains. Land System NW, subunit 'W' in Land Systems LW, HZ, BK, LK, NK; subunit 'hb' in land system BF, subunit 'pT' in Land System IF	Distinctive low akalche bush. High proportion of sclerophyllous shrubs, including tinta, chucum and stunted sapote
		Sibal	Gleys and peats of permanent freshwater swamps. Extremely poorly drained. Variable nutrient status	(85)	Large open swamps. Land System Type W, subunit B and swamps in Land Systems OA and TB	Herbaceous swamp. Mostly rushes and sedges. Some open water with floating lilies
		Ycacos	Gleys and peats of permanent saline and brackish swamps. Saline and extremely poorly drained	30, 32	Coastal swamps, with small pockets inland. Land System Type Y and Land Systems BN, BW and TB	Mangrove forests and savanna
Bahia	Shallow soils over Recent limestone	Consejo	Black peat or muck usually less than 25 cm deep, over gypsiferous limestone, with or without hard coral stone line. Imperfectly drained. Moderate nutrient status. Droughty	45	Low coastal plain around Chetumal Bay, especially on northern shore. Land System JI	Broadleaf forest, with patches of semi-swamp forest. Now much cleared for pastures, coconuts and tourism/residential developments

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
		Remate	Shallow darkish very stony mineral soils over coral, either massive or fragmented. Very droughty. Moderate nutrient status. Well drained	18	Low coastal plain round Chetumal Bay. Also coral gravel ridges in areas of Xaibe soils. Land System Type I	Low deciduous forest, with high proportion of sapote. Coastal areas used for pineapples and coconuts. Inland strips often included in sugar cane, vegetable, fruit cropping of surrounding Xaibe soils
Pembroke	Late Cenozoic limestone	Louisville	Black and dark grey clays over soft weathered limestone, with or without stone line of harder limestone. Variable depth and drainage. Good base and nutrient status. Droughty in shallower profiles. Drainage limitations in some deeper profiles	2, 46, 51, 52	Gently undulating plain of northern Corozal District. Land System ZZ	Originally high broadleaf forest with high proportion of cohunes. Now mainly cleared for sugar cane, and some fruit and vegetable cropping
		Concepcion	Dark brown clay over softish weathering limestone, often with intervening hard stone line. Good base status. Mostly rather droughty but drainage limitations in some deeper profiles	7, 53	Gently undulating plain of northern Corozal District especially south-eastern area around Concepcion-Libertad. Land System ZZ	Originally high broadleaf forest, often with many cohunes. Cleared for citrus orchards in early 1940s and balance of forest cleared for sugar cane from 1960 onwards
		Xaibe	Red clays, mostly shallow, over soft weathering limestone usually with an intervening hard limestone stone line. Good base status. Moderate nutrient status with possible P fixation. Often droughty	8, 20, 24	Undulating plains in eastern and northern Corozal District. Land Systems ZI, ZW, ZN	Northern area mostly under cultivation for sugar cane, and some citrus, pineapple and other fruits. Larger eastern area mostly under low broadleaf forest with many sapote, small mahogany and chechem
		Puluacax	Yellowish clays, often with grey mottled subsoils. May have sandy wash topsoils. Moderate good base status. Moderate–severe drainage limitations	19	Lower slopes along eastern part of Land System ZI. Land Systems ZW, ZN	Mixed low broadleaf forest with sapote and mahogany, and marsh forest with many pucte and botan

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
Yaxa	Mid-Tertiary limestone	Yalbac	Black, dark grey and dark brown clays, with blocky topsoils. Variable depth and drainage. Good base and moderate nutrient status. Shallow soils, droughty but drainage limitations in deeper lower slope profiles	15, 16, 17, 33, 34, 70 (JPL profiles, PV1, PV2, XV1, XV2, XV3, (R1+))	Rolling and undulating plain Land System Type K except for CK, Land Systems OX, HX, LX, HZ, LW, CZ, OA, NH, OD, OQ	High broadleaf semi-deciduous forest, with many sapote, mahogany and cohune. Some pucte and botan on wetter soils. Much remains under logged-over forest; but clared for milpa, cereals and sugar cane in north
		Jolja	Dark-coloured clays with many flints, either dispersed or in stone line. Rooting restrictions and droughtiness. Moderate base and nutrient status	11, 12, 50, 66	Rolling and undulating plains in north-west, above the Rio Bravo escarpment. Land Systems NH and NK. Intimately intermixed with Yalbac	Broadleaf semi-deciduous forest of variable stature. Quite stunted and verging to Broken Pine Ridge in places
		Chacluum	Shallow or moderately deep red clays over fairly hard limestone. Moderate nutrient status with possible P fixation. Rather droughty. Well-drained	35, 68	Undulating plain with low protruberant hills on tuffaceous limestone facies, especially around Hill Bank. Land Systems HZ, HX, OX	High semi-deciduous broadleaf forest with many mahogany, sapote, santa maria. Being developed for citrus
		Ramgoat	Reddish clay over bright yellowish deep clay. Extremely compact when dry. Moderate depth or greater. Drainage status unknown, possibly droughty. Rooting possibly restricted	47, 67	Undulating plain on tuffaceous limestone. Land Systems HZ and HX	Moderately high semi-deciduous broadleaf forest with sapote, santa maria and guanacaste
		Irish Creek	Red or yellowish clay over deep red and grey mottled clay. Good base and moderate nutrient status. Drainage imperfect and seasonally poor	69	Low areas and swamp margins in lower slope of Land System HZ	Low–moderate forest with many pucte and botan. Occasionally low akalche with logwood and chucum

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
Chacalte	Dark soils on Cretaceous limestone	Cabro	Shallow stony dark or reddish clay over limestone. Good base and moderate nutrient status. Well-drained. Droughty	77, (SC57, SC58)	Steep slopes of karst hills. Land Systems TX and BX	High broadleaf forest, often with many quamwood and cohunes
		Xpicilha	Moderately deep dark or reddish clays. Good base and moderate nutrient status. Well-drained. Moderate available water	64, (SC58)	Moderate–gentle slopes on lower sections of karst hills. Land Systems TX and BX	High broadleaf forest, often with many quamwood and cohunes
		San Lucas	Black or dark clay over deep, grey, mottled massive clay subsoil over limestone. Moderate base and nutrient status. Imperfectly drained. High available moisture capacity	76	Lower slopes and hillwash in karst terrain. Land Systems TX and BX	High broadleaf forest with botan as the main palm
Vaca	Brown soils on Cretaceous limestone	Cuxu	Dark and reddish brown clays of variable depths and drainage. Good base and moderate nutrient status. Droughty in shallow profiles	37, 78, 81	Steep and rolling terrain of Land Systems CX and CK. Also as minor soil in Land System TX	High semi-deciduous forest in part cleared for coffee plantations (since 1885)
Guinea Grass	Mid-Tertiary limestone with siliceous sand as impurities or thin drift	Lazaro	Dark medium-textured topsoil over dark or grey sandy clay subsoil over weathering limestone. Moderate base and nutrient status. Mostly well-drained and with moderate–high available moisture capacity	3, 5, 9, 10	Gently undulating plain between Hondo and New rivers in latitudes San Felipe-Douglas. Land System OZ	Originally high, semi-deciduous broadleaf forest, with many cohunes. Now largely cleared for sugar cane, sorghum, fruit cropping and pasture. Limited supplies of water for irrigated crop production during the dry season
		Pixoy	Dark coarse-textured topsoil (<15% clay) over grey medium- or fine-textured subsoil over weathering limestone. Moderate base but low nutrient status. Mostly well-drained. Coarser soils are droughty	1, 23, 65, 72	Gently undulating plain between Hondo and New Rivers in latitudes San Felipe-Douglas. Land System OZ	Originally high, semi-deciduous broadleaf forest, with many cohunes. Now largely cleared for sugar cane, sorghum, fruit cropping and pasture. Limited supplies of water for irrigated crop production during the dry season

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
Revenge	Siliceous drift over Late Tertiary limestone	Felipe	Dark coarse-textured topsoil over pale coarse upper subsoil over mottled and rather compact medium-textured lower subsoil. Acid and base-deficient topsoil. Drainage imperfect. Rather droughty topsoils	4, 44	Gently undulating plain north of San Felipe. Land System FP. Small pockets further east	Pine and Oak Ridge with open savanna. Has provided some small farmers with grazing for a few head of cattle in the past. Now being tested for small citrus orchards
		Tok	Coarse or medium-textured topsoil over pale mottled calcareous sandy clay-clay, extremely plastic and extremely sticky, over weathering limestone. Topsoil acid and low nutrient status. Subsoil poorly rooted and drained	21, 60	Gently undulating plain astride New Northern Highway. Land Systems QP and BH	Sparse Pine Ridge savanna with few pines and oaks. Main trees are stunted calabashes. No agriculture except for Trinidad Farms ranch
Altun Ha	Flinty and sandy Early Tertiary limestone	Jobo	Dark and brownish medium- and fine-textured flinty soils over limestone, often fairly hard	22, 25, 49, 55, 56, 57, 58	Intricate mosaic with soils of Tok Subsuite to east of New Northern Highway. Land Systems BJ, BH, BN	Semi-deciduous broadleaf trees of moderate height. Much cleared for pasture, pineapples, coconuts, mangoes and other fruit tree plantations
		Rockstone	Dark and brownish coarse-textured very stony flinty soils over limestone, often fairly hard	89	Intricate mosaic with soils of Tok Subsuite to east of New Northern Highway. Land Systems BJ, BH, BN	Semi-deciduous broadleaf trees of moderate height. Much cleared for pastures, pineapples, coconuts, mangoes and other fruit tree plantations
Stopper	Granite	Powder Hill	Shallow, pale coarse- or medium-textured, over granite at a depth of less than 60 cm. Acid and base-deficient. Low nutrient status. Droughty. Well-drained	(SC37)	Steep bouldery slopes on granite hills at low altitude. Land Systems SS and TR	High semi-deciduous broadleaf forest often with many cohunes. Soils erode rapidly from deforested slopes

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
		Mayflower	Moderately deep pale coarse- and medium-textured over granite at a depth of 60-150 cm. Acid and base-deficient. Low nutrient status. Moderate available moisture. Well-drained	(SC38, SC60)	Moderate slopes in undulating and rolling terrain on leucocratic granites at low altitudes. Land Systems SS and TR	High semi-deciduous broadleaf forest often with many cohunes. Soils erode rapidly from deforested slopes. Unsuited for agricultural development where slopes exceed 12°
		Canada Hill	Deep, red, medium- and fine-textured with granite at a depth of more than 60 cm. Acid and base-deficient. Well-drained. Good available moisture capacity	(SC20, SC39)	Moderate gentle slopes in rolling and undulating terrain on melanocratic granites at low altitudes. Land System SS	Currently citrus is being planted in these soils but natural forest should be left on all slopes exceeding 12°
		Pinol	Pale or yellowish coarse- and medium-textured topsoil over bright yellow and red medium-textured subsoil over deeply and intensively weathered granite. Very acid and base-deficient. Well-drained to rather droughty	38, 40, 41, (75)†, 79, 80	Rolling and steep terrain in granite basins of Mountain Pine Plateau. Land Systems MP and CR	Mountain Pine Ridge with *Pinus caribaea* predominant. Some cropping and pasture development attempted, but all failed and now used for pine logging and tourism
Ossory	Metasediments of Santa Rosa Group	Cabbage Haul	Shallow, grey and brown coarse and medium-textured over hard sandstone or argillite within 60 cm. Acid and base-deficient. Well-drained. Very droughty	(SC31, SC36)	Ridge crests and steep slopes at low and intermediate altitudes in Land System TR	Low–moderate broadleaf forest easily destroyed by fire. Exposing highly erodible soils on which a fire climax of scrubland dominated by 'tiger bush' develops
		Curassow	Deep, red and yellowish fine-textured over weathered argillite at more than 60 cm. Acid and base-deficient. Well-drained. Moderate available moisture	(SC8, SC34, SC59)	Moderate and gentle slopes on argillites at low and intermediate altitudes in Maya Mountains. Land Systems SO and TR	Moderate high broadleaf forest. Not suited for agricultural development on slopes steeper than 12°

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
		Pippen	Deep, red and yellowish coarse- and medium-textured soils over weathered quartzite or sandstone at more than 60 cm. Very acid and base-deficient. Well-drained. Moderately droughty	(SC32, SC54)	Gentle and moderate slopes on quartzites and sandstones at low and intermediate altitudes in Maya Mountains. Land System SO	Moderate-high broadleaf forest. May be replaced in patches by fire climax low scrub dominated by tiger bush. Slope limit for agriculture about 12-15°
		Dancing Pool	Deep red and yellowish hillwash soils. Variable texture, with variable contents of randomly orientated stones. More than 150 cm to hard rock. Acid and base-deficient. Well–imperfectly drained. Good available moisture capacity	(SC6, SC35)	Lower slopes on metasediments at low and intermediate altitude in Maya Mountains. Land System SO	High broadleaf forest. Soils unstable on slopes in excess of 20°
		Granodoro	Red, yellow and grey soils of moderate depth and medium textures, over weathering rock. Acid and base-deficient. Well-drained. Moderate available moisture	86, 87	Restricted to slopes of Grano de Oro hills. Land systems TX and VL	Moderate-low dry broadleaf forest. Much dumb cane and tiger bush in cleared areas. Patches of moisture forest with many rosewood trees in areas of seepage
		Machiquila	Deep red and yellow mottled outwash soil over limestone boulders. Slightly acid and base-deficient. Moderate–high available moisture capacity. Well–imperfectly drained	88	Outwash plains around Grano de Oro Hills. Land System TX	Moderately low dry broadleaf forest. Some former milpa areas. Currently regenerating after logging
		Cooma	Thin dark medium-textured topsoil over layer of ferruginized rock fragments, over moderately deep bright red and yellow medium- and fine-textured subsoil, over deeply and intensively weathered metasediments. Very acid and base-deficient. Well-drained. Slightly droughty	42, 74	Moderate slopes on less dissected remnants of Land System MP	Mountain Pine Ridge tree savanna and woodland, with moderate proportion of *Pinus patula techunumanii*. Some tiger bush and dumb cane in disturbed areas. Erodible and mainly unsuitable for agriculture

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
		Chiquibul	Shallow red and yellow soils of variable texture over highly weathered metasediments. Acid and base-deficient. Well-drained. Droughty	39	Steep slopes of deeply dissected sections of Land Systems MP and CR	Mountain Pine Ridge woodland and tree savanna, dominated by *Pinus patula techunumanii*. Highly erodible. Much tiger bush and dumb cane when disturbed
		Baldy	Grey and yellow very stony topsoil over prismatic or coarse blocky structured grey and yellow mottled subsoil of medium- or fine-texture, over deeply and intensively weathered metasediments. Very acid and base-deficient. Well or imperfectly drained. Slightly droughty	43	Gentle and moderate slopes of less dissected parts of Bald Hills plateau. Land System MP	Grassland and pine savanna, with many shaving brush sedge in ground cover. Stunted *Pinus caribaea* and crabboo are the main trees. Has been tried unsuccessfully for extensive sheep grazing in 1950s
Richardson	Bladen Volcanics	Palmasito	Deep red and yellow soils of medium and fine textures over deeply weathered metaandesite or metarhyolite. Very acid and base-deficient. Well-drained. High available moisture capacity	27, 28, 29	Crests and slopes of ridges on Balden Volcanics in Maya Mountains. Subunit 'v' of Land System TR	Tall forest with abundant tall *Coplothrinax cookii* palms on crests, and many very large santa marias on slopes. Undisturbed as yet, and geographically and topographically unsuited to agricultural development. Highly erodible when natural forest cleared
		Doyle	Similar to Palmasito but with superimposed micropodzolic topsoil. Fibrous litter over thin grey leached horizon, over dark illuvial humus horizon, over deep red and yellow soil of medium and fine texture, over weathered metaandesite and metarhyolite. Very acid and base-deficient. Well-drained. High available moisture capacity	26	Crests of highest parts of Bladen Volcanics ridge of main divide of Maya Mountains. Altitudes approx 1000 m. Subunit 'v' of Land System TR	Moderately high broadleaf forest with many tall *Coplothrinax cookii* palms. Undisturbed as yet. Highly erodible and unsuited to agricultural development

Suite	Parent material (and main soil features)	Subsuite	Characteristics	Type profiles* (Appendix 3)	Environment and distribution	Vegetation and current land use
		Ramos	Shallow red, yellow and brown soils of variable texture over weathered volcanics. Acid and base-deficient. Well-drained. Rather droughty	–	Steep slopes on Bladen Volcanics in Maya Mountains. Subunit 'v' of Land System TR	Tall broadleaf forest, with many santa marias. Some logging and milpa but mostly undistrubed. Areas with disturbed natural vegetation show signs of severe erosion. Unsuited to agricultural development

* The type profiles characterized in the course of this survey are in Appendix 3. Other profiles which provide useful data on individual soils are also listed in parantheses. The sources of these are:
SC=Stann Creek land resource assessment (King *et al.*, 1989).
JPL=The Tropical Rainforest Ecology Experiment of the Jet Propulsion Laboratory, National Aeronautic and Space Administration and National Geographic Society. These data will shortly be available from: Dr P. Schoenberger.
† Profiles transitional to other subsuites.

Table A2.2

Soil correlations

This survey		Previous Belizean surveys				International classifications	
Suite	Subsuite	Wright *et al.* (1959) (with set numbers)	Charter (1940, 1941)	Belize valley (Birchall and Jenkin, 1979)	Others	Legend of Soil Map of World (FAO/ UNESCO, 1988)	Soil Taxonomy (USDA, 1975; Fanning and Fanning, 1989; SMSS, 1990)
Turneffe	Shipstern	Shipstern (1b and 1c)	–	–	–	Lithic Leptosol, Eutric Leptosol	Lithic Troporthent
	Ambergris	Turneffe sand (1)	–	–	Cay Corker, Cay and Chapel (Darcel, 1952c)	Eutric Regosol	Troporthent, Tropopsamment
	Hopkins	Turneffe coarse sand (1a)	–	–	–	Dystric Regosol Gleyic Regosol	Orthic and Aqueptic Tropopsamment
	Matamore	Matamore sand and loam (46 and 46a)	–	–	–	Eutric or Dystric Regosol, Arenosol	Troporthent, Tropopsamment
Melinda	Monkey River	Monkey River (2, 2a, 2b and 2c)	Stevenson and Pelly suites	Quamina Subsuite	Savannah Bank (Wagner *et al.*, 1987)	Eutric and Dystric Fluvisol, Eutric and Dystric Gleysol	Eutric and Dystric Tropofluvents and Fluvaquents
	Quamina	Quamina (34-all)	Wood Series (calcareous phase)	Quamina Subsuite	Hershey (Wagner *et al.*, 1987)	Eutric Fluvisol	Eutric Tropofluvent
	Pasmore	Hondo clay and silty clay (3 and 3c)	–	Iguana and Cox series	–	Eutric and Millic Fluvisol. Some Eutric Gleysols	Eutric Tropofluvent and Fluvaquent
	Canquin	Canquin (38, 38a, 38b, 38e)	Stevenson (and Pelly) suites	Some of Redbank Subsuite	Melinda Series and some St Thomas Series (Wagner *et al.*, 1987)	Dystric Cambisol	Fluventic Dystropept
	Sennis	Sennis (41)	Baker Suite	Willows Bank Series	–	Fluvisol, Eutric or Dystric Planosol	Dystric Tropofluvent and Tropaquent, Albaquult and Albaqualf
Puletan	Crooked Tree	Puletan coarse sand (53b)	Baker Suite	Santos Pine Ridge and Double Head Cabbage series	Savannah Subsuite (King *et al.*, 1989)	Albic Arenosol, Dystric Planosol, Carbic and Humic Podzol	Tropopsamment, Albaquult, Tropohumod

This survey		Previous Belizean surveys				International classifications	
Suite	Subsuite	Wright *et al.* (1959) (with set numbers)	Charter (1940, 1941)	Belize valley (Birchall and Jenkin, 1979)	Others	Legend of Soil Map of World (FAO/ UNESCO, 1988)	Soil Taxonomy (USDA, 1975; Fanning and Fanning, 1989; SMSS, 1990)
	Boom	Puletan loamy sand (53a)	(Belize Suite)	Boom Subsuite	Savannah Subsuite (King *et al.*, 1989)	Dystric Planosol	Paleaquult, Haplaquult
	Bocotora	Pinol cherty loamy sand (52g)	–	Colonel English and part of Duck Run series	Savannah Subsuite (King *et al.*, 1989)	Dystric Planosol, some Plinthic Planosol	Paleaquult, some Plinthaquult
	Backlanding	Puletan (53e)	Belize Suite	Hattieville Series (clay phase)	Bladen Subsuite (King *et al.*, 1989)	Dystric Planosol	Haplaquult, Paleaquult
	Haciapina	Haciapina (50) with some Sibal (58)	Baker Suite	Little Creek and Crabcatcher series	–	Dystric Planosol, Dystric Gleysol, Gleyic Arenosol	Albaquult, Ochraquult, Umbraquult, Psammaquent
	Buttonwood	Puletan	Baker Suite	–	–	Saline, Eutric and Dystric Planosol	Albaqualf, Paleaqualf
Tintal	Pucte	Pucte (55, 55a and 55b)	Kinloch (Douglas) Series	Creek Subsuite	–	Eutric and Mollic Gleysol	Tropaquept
	Chucum	Chucum (56 and 56a)	Turner, Sarawe, English Creek, Cave and Kinloch series	Chucum Subsuite	–	Stagni-eutric Gleysol	Eutric Tropaquent
	Sibal	Sibal (58), Some Caway (57)	Sarawe and Yo Creek suites	Swamp Suite	–	Dystric, Eutric, Umbric, Mollic Gleysol. Some Histosol	Fibrist, Fluvaquent, Hemist
	Ycacos	Ycacos (59)	Sibun and Burdon and Haulover suites	Ycacos Subsuite	–	Eutric and Thionic Gleysol. Fibric and Thionic Histosol	Tropaquent, Tropaquept, Fibrist, Hemist, Hydraquent
Bahia	Consejo	Consejo (4)	Consejo Suite	–	Consejo (Darcel, 1952c)	Humic, Eutric and Lithic Leptosol and Cambisol	Lithic Eutropept (Gypsic Humitropept)
	Remate	Remate (5, 5a, 5c and 5d)	–	–	Remate sandy clay (Darcel, 1952c)	Rendzic, Lithic and Eutric Leptosol	Lithic Eutropept and Rendoll
Pembroke	Louisville	Louisville (6, 6a and 6c)	Louisville Suite, Estevan Series	–	–	Eutric and Vertic Cambisol, Pelli-eutric Vertisol	Rendollic and Vertic Eutropept, Pelludert

This survey		Previous Belizean surveys				International classifications	
Suite	Subsuite	Wright *et al.* (1959) (with set numbers)	Charter (1940, 1941)	Belize valley (Birchall and Jenkin, 1979)	Others	Legend of Soil Map of World (FAO/ UNESCO, 1988)	Soil Taxonomy (USDA, 1975; Fanning and Fanning, 1989; SMSS, 1990)
	Concepcion	Louisville (6b) Xaibe (8b, 8c and 8d)	Xaibe Suite (Calcutta Series)	–	–	Eutric Cambisol Rendzic Leptosol	Chromic Eutropept, Rendoll
	Xaibe	Xaibe (8, 8a)	Xaibe Suite (Xaibe Series)	–	–	Chromic Cambisol, Chromic Luvisol	Eutropept, Rhodudalf
	Puluacax	Puluacax (7, 7a, 7b) and part of Xaibe (8)	Xaibe Suite (part of Maskall Series)	–	–	Eutric, Chromic and Gleyic Cambisol	Eutropept, Tropaquept
Yaxa	Yalbac	Yaxa (9-all)	La Flore and Ceiba suites	Yalbac Subsuite	–	Rendzic Leptosol, Vertic and Eutric Cambisol, Pelli-eutric Vertisol	Eutropept, Rendoll, Pelludert
	Jolja	Jolja (13-all)	–	Yalbac Subsuite	–	Eutric Leptosol, Eutric Cambisol	Skeletal Eutropept, Rendoll
	Chacluum	Chacluum (11-all)	Soccotz Suite	Chacluum Subsuite	Chacluum (McCormack, 1987)	Chromic Cambisol, Chromic Luvisol	Eutropept, Rhodudalf
	Ramgoat	Ramgoat (10, 10a, 10b)	?Soccotz Suite	–	–	Gleyic, Chromic and Ferric Luvisol and Cambisol	Rhodudalf, Eutropept
	Irish Creek	?Ramgoat (10c)	–	Tillet and Potts Series	Hachacluum (McCormack, 1987)	Eutric Gleysol	Eutric Topaquept
Chacalte	Cabro	Cabro (62-all), Dry Creek (61 and 61a) Hummingbird (15H)	La Flore, and Gracie Rock suites. Mountain Cow Series	–	Dry Creek Series (Wagner *et al.*, 1987)	Rendzic Leptosol	Lithic and Rendollic Eutropept
	Xpicilha	Chacalte (17a, 17c) Xpicilha (18) Hummingbird (15, 15a)	La Flore and Gracie Rock suites	–	Hummingbird Series (part) (Wagner *et al.*, 1987)	Humic and Vertic Cambisol	Vertic and Rendollic Eutropept
	San Lucas	Chacalte (17) Xpicilha (18 part) Humming-bird (15a)	St Thomas Suite	–	Hummingbird Series (part) (Wagner *et al.*, 1987)	Eutric Vertisol, Vertic or Eutric Cambisol	Pelludert, Pelludertic Eutropept

This survey		Previous Belizean surveys				International classifications	
Suite	Subsuite	Wright *et al.* (1959) (with set numbers)	Charter (1940, 1941)	Belize valley (Birchall and Jenkin, 1979)	Others	Legend of Soil Map of World (FAO/UNESCO, 1988)	Soil Taxonomy (USDA, 1975; Fanning and Fanning, 1989; SMSS, 1990)
Vaca	Cuxu	Tsiminkax (16) Cuxu (14-all) Hummingbird (15, 15H—part)	Ceiba, Soccotz and Gracie Rock Suites	Cuxu Subsuite	–	Chromic and Vertic Cambisol, Mollic and Lithic Leptosol	Rendollic and Chromudertic Eutropept
Guinea Grass	Lazaro	Lazaro (12-all)	San Pablo Series. Orange Walk Series	–	–	Eutric Cambisol, Haplic Luvisol	Eutropept, Hapudalf
	Pixoy	Pixoy (20-all)	Orange Walk Series (part)	–	–	Eutric Planosol, Haplic Luvisol	Hapludalf, Albaqualf, Haplaqualf
Revenge	Felipe	Felipe (23)	Orange Walk Series (part)	–	–	Humic and Eutric Planosol	Aquollic and Typic Albaqualf
	Tok	Tok (24)	Tower Hill Rockstone Pond, Kate's Lagoon Series	(Yobo Subsuite)	–	Eutric and Gleyic Planosol	Albaqualf
Altun Ha	Jobo	Jobo (21-all)	Maskall Series – part of Rockstone Pond Series	–	–	Rendzic Leptosol, Eutric Cambisol, Haplic Luvisol	Eutropeptic Rendoll, Rendollic Eutropept, Hapludalf
	Rockstone	Rockstone (22, 22a)	Rockstone Pond	–	–	Lithic, Eutric and Rendzic Leptosol, Mollic Cambisol, Luvisol	Rendollic Eutropept, Rendoll, Hapludalf
Stopper	Powder Hill	Stopper (33H), Swasey (64), Sirin shallow (40H)	–	–	–	Dystric Leptosol and Cambisol	Lithic Dystropept
	Mayflower	Sirin gritty loam (40)	Marie Series	–	–	Dystric Cambisol, Haplic Acrisol	Dystropept, Hapludult
	Canada Hill	Stopper (33 & 33H)	Marie Suite	–	–	Haplic Acrisol, Rhodic Ferralsol	Hapludult, Haplorthox
	Pinol	Pinol (52, 52H, 52d, (52e), 52f)	Blancaneau Series	–	–	Dystric Cambisol, Haplic Acrisol	Oxic Dystropept, Hapludult

This survey		Previous Belizean surveys				International classifications	
Suite	Subsuite	Wright *et al.* (1959) (with set numbers)	Charter (1940, 1941)	Belize valley (Birchall and Jenkin, 1979)	Others	Legend of Soil Map of World (FAO/ UNESCO, 1988)	Soil Taxonomy (USDA, 1975; Fanning and Fanning, 1989; SMSS, 1990)
Ossory	Cabbage Haul	Raspacula (65-all)	Shallower Vaca, Macaroni and Mico series of Marie Suite	–	–	Dystric Leptosol and Cambisol	Lithic Dystropept
	Curassow	Curassow (35, 35a and 35H)	Deeper Vaca, Macaroni, and Mico series	–	–	Haplic and Ferric Acrisol	Dystropeptic and Orthoxic Hapludult
	Pippen	Ossory sandy clay loam (36, 36a and 36H)	Vaca Series	–	–	Haplic and Ferric Acrisol	Dystropeptic and Orthoxic Hapludult
	Dancing Pool	Curassow gravelly loam (35b), Ossory silty loam (36b)	Marie Suite	–	–	Dystric Regosol, Dystric Cambisol	Dystric Troporthent, Dystopept
	Granodoro	Granodoro (51 and 51H)	Vaca and Macaroni series	–	–	Dystric Cambisol, Haplic Acrisol	Dystropept, Hapludult
	Machiquila	Machiquila (48 and 48a)	San Pastor Series (part)	–	–	Chromic Luvisol, Eutric Cambisol	Kandudalf, Kanhapudalf, Eutropept
	Cooma	Pinol (52a, 52aH, 52b, 52bH, 52c, 52cH)	Chalillo, Silkgrass, Canada series of Croja Suite	–	–	Dystric and Plinthic Cambisol, Plinthic Acrisol	Dystropept, Plinthudult
	Chiquibul	Chiquibul (39H, 39aH)	Dry Creek Chalillo, Canada Series of Croja Suite (parts)	–	–	Dystric and Lithic Leptosol, Dystric or Chromic Cambisol	Lithic Dystropept
	Baldy	Pinol (52b and 52C)	Dry Creek Series (part)	–	–	Haplic Alisol and Acrisol, Dystric Cambisol	Hapludult, Dystropept, Humitropept
Richardson	Palmasito	Richardson Peak (68), Palmasito (43, 43H, 43aH-part)	–	–	–	Haplic and Humic Ferralsol, Acrisol and Alisol	Hapludox, Hapludult
	Doyle	–	–	–	–	Humic Ferralsol, Alisol, Acrisol	Acrudox, Kandiudult, Paleudult
	Ramos	Richardson Peak (68)	–	–	–	Ferallic and Dystric Cambisol	Dystropept

Table A2.3

Agricultural suitability of soil subsuites

Suite	Turneffe				Melinda					
Subsuite	Shipstern	Ambergris	Hopkins	Matamore	Monkey River	Quamina		Pasmore	Canquin	Sennis
						River alluv.	Karst basin			
Cacao	N2r	N2mn	N2m	N2mn	S3wf	S2m-S3wf	S3w-N1d	N1w	S2r-S3r	S3wr-N2m
Cashew	N2r	S3n	S2m	S1	S3wf	S3wf	S2w-N2r	N2w	S3r	N1r-N2w
Citrus	N2r	N1mn	N2m	S2mn-S3mn	S2f	S1-S2f	S1-N1w	N1wn	S1	S3n-N1w
Coconuts	N1n	S3n	S3m	S2mn	S1	S1	S2n	S3w	S2r	S2w
Cotton	N2r	N2mn	N2m	N1mr	S3n	S2bn	S2n	S2nw	S3rb	N1n-N2rb
Pasture	N1m	S3mn	S3m	S3m	S1	S1	S1-S2m	S1-S2n	S1	S2m-S3w
Papaya	N2r	N2mn	N1m	S3m	S2f	S2f	S2n	S2nw-N1w	S2r-S3r	S3nw
Maize (mech.)	N2nm	N2mn	N2m	N2mn	S1-S2f	S1-S2f	S2n	S2wn-S3wn	S3nd	S2wn-N1w
Rice (mech.)	N2m	N2m	N2m	N2m	S2fm	S2fm	S2k-N2nm	S1-S3m	S3m	S2n-N1m
Sorghum	N2nm	N1mn	N1m	S3mn	S2f	S2f	S2m	S2w	S2n	S2f-N1w
Soya	N2nm	N2mn	N2m	N1mn	S3w	S3w	S2n-S3w	N1wn	S3n	S3nw
Sugar cane	N2m	N2mn	N2m	N1m	S2f	S2f	S2nb	S1-S3wn	S2bn	S3w
Vegetables	N2nm	N2mn	N1m	N1mn	S1-S2n	S1-S2n	S2nk-N1d	S3wn-N1wn	S2nd	S2n-N1wn
Pineapple	N1n	S3n	S3m	S2mn	S3f	S3f	S2n-N1m	N1wn-N2wn	S2d	S3nw-N1nw
Robusta coffee	N2r	N2mn	N2m	N2mn	S3w	S3w	S3w	N2wn	S2r	S3w-N2wn
Other	Sanseviera S3nr									
Milpa	N2mr	N2mn	N2m	N2mn	S1*	S1*	S1*-S2n	S1*-S3wn	S2r	S2w-N2nr

* Suitability for dry season crop (matahambre)

Suite	Puletan								Tintal		
Subsuite	Crooked Tree	Boom		Bocotora	Backlanding		Haciapina	Buttonwood	Pucte		Chucum
		Mod. compact	Very compact		Mod. compact	Very compact			Deep	Shallow	
Cacao	N2mn	N2nm	N2mn	N2nr	N2nw	N2nw	N2nw	N2nz	N2w	N2w	N2wn
Cashew	S1-S2mn	S3mn	N2r	S3mn-N2nr	N2rw	N2rw	N2w	N2nz	N2w	N2w	N2wn
Citrus	S2mn-N1mn	N1mn	N2mn	N1nr-N2nr	N1wn	N2wn	N1wn	N2nz	N2w	N1w-N2w	N2wn
Coconuts	S2mn-S3mn	S3nm	N1mn-N2mn	S3wn-N2wn	S3wn	S3mn-N1nw	S3wn-N1nw	N1nz	N1w	S3w	N1wn-N2wn
Cotton	N2mn	N2mn	N2mn	N2wn	N2wn	N2wn	N2wn	N2nz	N2w	N2w	N2wn
Pasture	S2mn-S3mn	S3mn	N1wn	S3n-N1n	N1wn	N2nw	S3wn	N2nz	S3w	S2w	N1wn-N2wn
Papaya	S3mn-N2mn	N1m	N2m	N1wn-N2wn	N1wn	N2wn	N1wn-N2wn	N2nz	N2w	N1w	N2wn
Maize (mech)	S3nm-N2mn	N2mn	N2mn	N2wn	N2wn	N2wn	N2wn	N2nz	N2w	N1w	N2nw
Rice (mech)	N2m-S3mn	S3mn	S2mn	S3mn-N1mn	S2n-S3n	S3n-N1n	S2nq-S3nq	N2nz	S2n-S3n	S2nm-S3mn	S3mn-N2mn
Sorghum	N1mn	N1mn	N2mn	N2wn	N2wn	N2wn	N2nw	N2nz	N2w	S2w-S3w	N2wn
Soya	N2m	N2mn	N2mn	N2mn	N2wn	N2wn	N2nw	N2nz	N2w	N1w	N2wn
Sugar cane	N1mn-N2mn	N1mn	N2mn	N2wn	N2wn	N2wn	N2nw	N2nz	S3w-N1w	S2w-S3w	N1wn-N2wn
Vegetables	S3mn-N1mn	S3mn	N1mn-N2mn	S3mn-N2mn	S3mn	N1mn	N1nm	N2nz	S3w-N1w	S2w	N1wn-N2wn
Pineapple	S2mn	S3mn	N1mn	S3n-N1wn	S3mn	S3mn	S3wn	N2nz	N1wn	N1wn	N2wn
Robusta coffee	N1mn-N2mn	N2mn	N2mn	N2wn	N2wn	N2wn	N2nw	N2nz	N1w-N2w	S3w-N1w	N2wn
Milpa	N2mn	N2mn	N2mn	N2nr	N2w	N2w	N2wn	N2nz	S3wn	S2wn	N2wn

Suite	Tintal (cont.)		Bahia		Pembroke				
Subsuite	Sibal	Ycacos	Consejo	Remate	Louisville		Concepcion	Xaibe	Puluacax
					Shallow and modal	Deep and mottled			
Cacao	N2w	N2wz	N2r	N2m	N2mr	N2nw	N1mr	N1nm-N2nm	S3w-N2w
Cashew	N2w	N2wz	N2r	N2r	N2r	N2w	N1r	N2r	N1w-N2w
Citrus	N2w	N2wz	N1r-N2r	N2mr	N1nr	N1wn	S2mn	S2nm-N1nm	S3wn-N2w
Coconuts	N2w	N2wz	S2n-N1nw	S2r-N1nr	S2mn	S3w	S3nm	S2nr-S3nr	S3w-N1w
Cotton	N2w	N2wz	N2r	N1r-N2r	S2mn	S2nw	S3nm-N1nm	S3nm-N2mn	N1wn-N2wn
Pasture	N1kw	N2wz	S2mn-N1w	N1m	S2mn-S3mn	S1-S2n	S2mn-S3nw	S2mn	S2n-N1nw
Papaya	N2w	N2wz	S3nr	N1nm-N2nm	S3mn-N1mn	S2nw-N2w	S2mn-N1wn	S2mn	N1wn
Maize (mech)	N2w	N2wz	S3r-N1r	N1mk-N2mk	S2nm	S1-S3wr	S3mn	S3mn-N1mn	S2nw-N1wn
Rice (mech)	N1kw	N2wz	N2m	N2m	S3mn	S1-S2m	N1mn	N2mn	S2n-S3nm
Sorghum	N2w	N2wz	N2w	S3m-N1mk	S2mn	S2w	S2mn	S2mn-S3mn	S3nw-N2nw
Soya	N2w	N2wz	N2rw	N2mk	S3mn	N1wn	S2nm-N1nw	S2nm-N1m	N1wn
Sugar cane	N2w	N2wz	S3wn	S3mn-N1mn	S1-S3nm	S1-S3w	S2n>S1	S2mn-S3mn	S2nw-N1nw
Vegetables	N2w	N2wz	N2rw	N1m-N2mk	S2mn	N1wn	S2nm	S3mn	S2nw-N1w
Pineapple	N2w	N2wz	N1n-N2w	S2m-N2mn	N1n	N1wn-N2wn	S2n-S3nw	S1-S3mn	S2w-N1w
Robusta coffee	N2w	N2wz	N2nr	S3rn-N2mr	S2mr-N1mr	N2nw	S1-S3m	S2mn-N1mn	S3wn-N2w
Other				Avocado					
Milpa	N2w	N2wz	N1rw	S2nr-N2w S3m-N2m	S2mn-S3mn	S1-S2wn	S3mn	S2mn	S3n-N1w

Suite	Yaxa							Chacalte		
Subsuite	Yalbac			Jolja	Chacluum	Ramgoat	Irish Creek	Cabro	Xpicilha	San Lucas
	Shallow	Modal	Deep and mottled							
Cacao	N1mn	S3m-N1nm	N1w	N1nm	S3nm-N1nm	S3nr	N2w	S3m-N1m	S2m	S2w-N1w
Cashew	N2rm	N2n	N2w	N2mr	N1mn-N2mn	N1rw	N2w	N2m	N2mr	N1w-N2w
Citrus	N1nr	S3mn-N1mr	N1wn	S3mn-N1nm	S2n-N1nm	S2n-N1n	N1w-N2w	N2m	S3m-N1mn	S3w-N1w
Coconuts	S3mr	S3mr	N1w	S3nr-N1nr	S3n-N1nm	S3nr	N1w	N2m	S3n	N1w
Cotton	S3mn	S3mn	S3wn-N1kw	N1kn-N2kn	N1nm	S3nr-N1nr	N2w	N2me	S3n-N1n	S3nb-N1nw
Pasture	S1-S2m	S1	S2w-S3w	S2kn-S3k	S2n-S3nm	S1-S2n	S3nw	N1m	S3q	S1-S2w
Papaya	S3nm	S2nm	S3nw	N1nm	S3nm	N1nr	N1w	N2m	S3mn-N1mn	S2w-S3w
Maize (mech)	S2nk-S3k	S2nk	S2kw-N1w	S3km-N1km	S3nm	S3nr	N1wn	N2me	S3mq	S2kw
Rice (mech)	N1m	S2m	S1	S3mk-N1mk	N1m	S3mn-N1mn	S2n-S3n	N2me	N2mq	S2m-S3m
Sorghum	S2m-S3k	S1-S2k	S2kw-N1w	S3km-N1k	S2mn	S3nr	N2w	N1e	S3qn	S2kw
Soya	S3mk	S3nk	N1w	S3km-N1km	S3n	N1nr	N2wn	N2me	N1mq	S3kw
Sugar cane	S2nm	S1	S2w	S3km	S3nm	S3n	N1w	N2me	S3qm	S2w
Vegetables	S3mn	S2nk	S3wk	N1km	S3mn	S2nr-N1nr	N1w	N2me	S3q	S2kw
Pineapple	N1n	N1n	N2wn	S3nm-N2nw	S2n	S2n-S3m	N1w	N2n	N1nm	S3w-N1n
Robusta coffee	N1m	S3mn	N2w	S3nr-N2mn	S2nm-N1m	S2nr-S3rn	N2w	N1m	S3m-N1m	N1wn
Milpa	S2m	S1	S1-S2w	S3mn-N1mn	S3mn	S3n	S3wn-N1wn	N1n-N2n	S2m-N1m	S2n-S3w

Suite	Vaca		Guinea Grass				Revenge		Altun Ha	
Subsuite	Cuxu		Lazaro		Pixoy		Felipe	Tok	Jobo	
	Shallow	Less shallow	Shallow and modal	Mottled	Slope	Mottled			Slope	Mottled
Cacao	N2m	S3m-N1m	N1m	N1w	N1mn	N1wn	N2wn	N2wn	N1m	N2w
Cashew	N2mr	N1mr	S3r	N1w	S2n-S3nr	N1wn	S3wn-N1wn	N2wn	N1r	N2w
Citrus	N1mr	S3mn-N1mn	S2nm-S3nm	N1w	S2nm	N1wn	N1wn	N2wn	S2nm-N1mr	N2w
Coconuts	S3mk	S3n	S1-S3nm	S3w	S1-S3nm	S3w	S3wn-N1w	N1wn>S3wn	S2nm	N1w
Cotton	N2m	N1k	S2nm	S3w	S3nm	S3w	N2n	N2wn	N1kn	N2kw
Pasture	S3mk	S2mk	S1	S1-S2w	S2n	S1-S2wn	S3wn	S3wn-N2wn	S2n	S3wk-N1w
Papaya	N2m	S3mn-N1mn	S2mn	S3wn	S3mn-N1mn	N1wn	N1wn	N2wn	S3nm	N1nw-N2wn
Maize (mech)	N2mk	N1k	S2mn	S3nw	S2mn	S3nw	N1wn	N2wn	S3kn	N1kw
Rice (mech)	N2m	N1mk-N2mk	S3mn	S2mn	N1mn	S3mn	S3mn	S3mn-N2m	S3km-N2km	S2kn
Sorghum	N2mk	S3k	S1-S2n	S3nw	S1-S2n	S3nw	N1wn	N2wn	S3kn-N1kn	N1kw-N2wk
Soya	N2mk	N1mn	S2mn	S3wn-N1wn	S3mn	N1wn	N1wn	N2wn	N1kn	N2kw
Sugar cane	N2m	S3m-N1m	S1	S3w	S1	S3wn	S3wn-N1wn	N1wn-N2wn	S2mn	S3wn
Vegetables	N2mk	S3m-N1m	S1-S2n	S3wn	S1-S2n	S2wn-S3wn	S3wn	S3wn-N2wn	S3mn	S3wn-N1wn
Pineapple	N1mn	S2n-N1n	S2n	S3wn	S1-S2n	S3wn	S3wn	S2mn-N1wn	S2nm	N1w
Robusta coffee	N1m	S2mn-S3mn	S2m-S3m	N1w	S3mn-N1mn	N1wn-N2wn	N2wn	N2wn	S2mn-N1mn	N2wn
Milpa	S3m-N1m	S2mn-N1mn	S1	S3w-N1w	S2nm	S3wn-N1wn	N2wn	N2wn	S2mn	N1w

Suite	Altun Ha (cont.)	Stopper				Ossory				
Subsuite	Rockstone	Powder Hill	Mayflower	Canada Hill	Pinol	Cabbage Haul	Currassow	Pippen	Dancing Pool	Granodoro
Cacao	N2mn	N2e	S2n-S3ne	S2ne	N2nc	N2e	S2mn-S3n	S2mn-S3n	S2n	N2mn
Cashew	S3nr-N2nr	N2e	S2e-S3e	S2ne-S3ne	N2n	N2e	S3r	S3r	S2w	N2nr
Citrus	S2nr-N2nr	N2e	S2en-S3ne	S2ne-S3ne	N2nm	N2e	S2mn-S3mn	S3mn	S1	N1nm-N2nm
Coconuts	S3mn-N1mn	N2e	S2e-S3e	S2ne	N2cn	N2e	S3mn	S3mn	S2n	N1cn
Cotton	N2km	N2e	N2nm	N1nm	N2nm	N2e	N1mn	N1mn	N1nb	N2bn
Pasture	S3nk	N2e	S2n	S2n	S3nm	N2e	S2mn	S2mn	S1-S2n	S2nm-S3mn
Papaya	S3nr-N2nr	N2e	N1nm	S3ne	N2nm	N2e	S3mn	S3mn-N1mn	S2n	N2nm
Maize (mech)	S3km-N2km	N2e	S2n-N1ne	S2n-N1ne	N2mn	N2e	N1m	N1m	S3nb-N1nb	N2bm
Rice (mech)	N1km-N2kn	N2em	N2me	N1m-N2me	N2mn	N2e	N2m	N2m	S3m	N2mb
Sorghum	S3km-N2kn	N2e	S2n-N1ne	S2n-N1ne	N2nm	N2e	S3n	S3n	S3nb	N1bm
Soya	N2kr	N2e	S3me-N1ne	S3ne-N1ne	N2mn	N2e	N1m	N1m	S3nb-N1bn	N2bm
Sugar cane	S3rn-N2m	N2e	S3ne-N1me	S3ne-N1ne	N2mn	N2e	N1n	N1n	S3nb	N2nm
Vegetables	S3kn-N2k	N2e	S3en-N1me	S2n-N1me	N1nm	N2e	S3n-N2d	S3n-N2d	S3n-N1dn	N1nm
Pineapple	S2nr-N1nr	N2e	S2e-S3ne	S1-S3e	N1nm	N2e	S2r-S3r	S2r-S3r	S1-S2n	S3nr
Robusta coffee	N2nr	N2e	S2n-S3ne	S2ne-S3ne	N2nm	N2e	S2nm	S2nm	S1-S2n	S3nr-N1nr
Milpa	N1mn	N2e	N1ne-N2ne	S2ne-N1ne	N2mn	N2e	N1n-N2n	N2n	S3n-N1n	N2mn

Suite	Ossory (cont)				Richardson		
Subsuite	Machiquila	Cooma	Chiquibul	Baldy	Palmasito	Doyle	Ramos
Cacao	N2nw	N2nc	N2r	N2nc	S3n-N2e	N1n-N2e	N2e
Cashew	N2rw	N2nc	N2r	N2nc	S3c-N2e	S3c-N2e	N2e
Citrus	N1nw-N2nw	S3nm-N2nr	N2r	N2nm	S2n-N2e	S3n-N2e	N2e
Coconuts	S3nw-N1nw	N2nc	N2cr	N2nc	S3c-N2e	N2nc	N2e
Cotton	N2nw	N2nm	N2r	N2nm	S3nc-N2en	N1n-N2en	N2e
Pasture	S2nw-S3nw	S2nm-S3nm	S3r	S3nm-N2nm	S2n-N1en	S3n-N1en	N1e-N2e
Papaya	N2nw	N1nm-N2mr	N2r	N2mn	S3n-N2en	N1n-N2en	N2e
Maize (mech.)	S3nw-N2nw	N1nm	N2r	N2nm	S2n-N2en	S2n-N2en	N2e
Rice (mech.)	S2nm-N1nm	N2mn	N2nr	N2mn	N2mn	N2mn	N2mn
Sorghum	N2nw	N1mn	N2r	N2mn	S2n-N2en	S2n-N2en	N2e
Soya	N2nw	N2nm	N2r	N2mn	S3n-N2en	S3n-N2en	N2e
Sugar cane	S3nw-N1nw	N2nm	N2r	N2mn	N1c-N2ec	N1c-N2ec	N2e
Vegetables	N1nw-N2nw	S3nm-N1nm	N2r	N1mn-N2mn	N1n-N2en	N1n-N2en	N2e
Pineapple	S3nw-N1nw	N1nm	N2r	N1mn	S3c-N2ec	S3c-N2ec	N1e
Robusta coffee	N1nw	S2nm-S3nm	N2r	N1mn	S2n-N2en	S2n-N2en	N2e
Milpa	N1nw-N2nw	N2mn	N2r	N2mn	S2n-N2e	S2n-N2e	N2e

APPENDIX 3: SOIL PROFILE DESCRIPTIONS AND ANALYSES

The soils were described in purposely dug profile pits or, rarely, in freshly cut-back road cuttings. The descriptions are of conventional form and nomenclature (FAO, 1971). Disturbed samples were taken from the centre sections of selected major horizons. They were airlifted in Belize, and most of them shipped to the laboratory of the Tropical Soils Analysis Unit of the NRI, Chatham. The remainder were delivered to Central Farm, Cayo.

In the descriptions and analyses, the profiles are listed in numerical order, which is roughly the same as the chronological order of description. In addition to the fully described profiles, one augering (Number 380) was sampled for analysis because of possible salinity.

Laboratory methods of soils analysis

The methods used by the Tropical Soils Analysis Unit for the samples analysed in Chatham were:

Preparation – The samples were dried in the field and the larger stones discarded. In the laboratory they were further air-dried and the aggregates crushed. The fine earth passing though a 2 mm sieve was retained for analysis.

Moisture – A subsample of air-dried fine earth was weighed, dried for 16 hours at 105°C, and then reweighed. 'o.d.s.' indicates 'oven-dried soil'.

Weight:volume ratio – A sample of air-dried fine earth were measured with a 10 ml scoop and weighed. 'a.d.s.' indicates 'air-dried soil'.

Electrical conductivity (1:5 soil:water) – 10 ml of fine earth was shaken in 50 ml distilled water for 30 min. The suspension was allowed to settle before the conductivity of the solution was measured with a direct-reading conductivity meter.

pH (1:5 soil:water) – Following the determination of electrical conductivity, the pH of the suspension was measured using a pH meter with a glass/reference dual electrode.

pH (1:5 soil:KCl) – 10 ml of fine earth were shaken in 50 ml 1 M KCl for 30 mins. The suspension was allowed to settle and the pH of the suspension was determined using a pH meter with a glass/reference dual electrode.

Soluble Na and K, and exchangeable Na, K, Mg, and Ca – 5 g of air-dried fine earth were mixed with acid-washed fine sand and placed in a filter funnel. If the electrical conductivity (1:5 soil:water) had been above 0.5 mS/cm the soluble Na and K were extracted by prewashing with aqueous methylated alcohol. The exchangeable cations of all samples were extracted by leaching with 200 ml of 1M ammonium acetate.

Na, K, Mg and Ca concentrations in the leachates were determined by atomic absorption spectrophotometry (AAS), using 1,000 ppm Sr as a releasing agent.

Cation exchange capacity – After leaching with ammonium acetate, the soil was washed with aqueous methylated alcohol. Absorbed ammonium was leached from the soil with 1M KCl solution, and the ammonium in the leachate was determined colorimetrically as indophenol-blue by continuous flow analysis. 'TEB' denotes 'total exchangeable bases'.

Base saturation – By calculation as (sum of exch Na+K+Mg+Ca/cation exchange capacity) ×100

Base saturation percentages are not particularly useful in very coarse textured horizons with low organic matter contents. The cation exchange capacities may be very low, so that even small contents of exchangeable bases can lead to high saturation percentages in quite acid soils, e.g. horizons 2 and 4 in profile OZ 54.

'Total' N (not including nitrate or nitrite) – 100 mg of finely ground oven-dried fine earth were digested at 360-370°C for 2.5 h with 2 ml concentrated sulphuric acid containing 0.4% selenium and 1 g sodium sulphate. Nitrogen was determined colorimetrically as indophenol-blue by continuous flow analysis.

Organic carbon (Walkley and Black) – An amount of finely ground fine earth, estimated from the nitrogen content to contain 10-15 mg of carbon, was digested with 0.17M potassium dichromate solution and 20 ml concentrated sulphuric acid. Organic carbon was determined using a probe colorimeter with sucrose as the standard, digested in the same way.

Exchangeable Al – For most horizons in profiles with a horizon of pH (in water) less than 5.5, 10 g of fine earth were leached with 10 aliquots of 10 ml 1M KCl solution. The aluminium concentration of the leachate was determined by AAS.

Available P (Bray) – 5 ml of fine earth were shaken for 1 min with 50 ml of a solution containing 0.03M ammonium fluoride and 0.1M HCl. Phosphorus was determined as molybdenum-blue by continuous flow analysis, using ascorbic acid as the reducing agent. The Bray extraction was done for all samples, but the results from the Olsen extraction are more meaningful in calcareous soils.

Available P (Olsen) – For all horizons in profiles with any horizon of pH (in water) above 7, 5 ml of fine earth were shaken for 30 min with 100 ml sodium hydrogen carbonate solution, adjusted to pH 8.5. Phosphorus in the filtrate was determined colorimetrically as molybdenum-blue, using ascorbic acid as the reducing agent and potassium antimony tartrate as a catalyst.

Total nutrients (perchloric acid digestion) – 200 mg of finely ground fine earth were digested for 4.5 hours at 200°C with 60% perchloric acid. P concentration in the digest was determined colorimetrically; the other elements by AAS.

Calcium carbonate – All soils with pH (in water) above 6.5 were tested with 50% HCl. The calcium carbonate equivalents of those that effervesced were determined using a calcimeter that measured the volume of CO_2 evolved with excess HCl in the cold. The calcimeter was calibrated with standard $CaCO_3$ samples.

Particle size analysis – About 10-12 g of fine earth were digested with hydrogen peroxide to destroy organic matter. If the electrical conductivity found for the sample (in 1:5 soil:water suspension) was greater than 0.5 mS/cm, soluble salts were removed by stirring the sample with water, centrifuging and discarding the clear solution. The washing step was repeated until the conductivity of the stirred suspension was less than 0.5 mS/cm. The soil was dispersed by ultrasonic vibration in a solution containing 0.25% W/V sodium hexametaphosphate and 0.035% sodium carbonate. Silt and clay contents were determined by pipette sampling, after sedimentation in a 20°C controlled-temperature water bath. The pipetted aliquots were dried and weighed. The sand was separated into 4 fractions by dry sieving, and the content of each was determined by weighing. The results were reported on the basis of dry mineral soil, with organic matter and soluble salts removed.

Soil Classification	Suite Guinea Grass	Subsuite Pixoy
Soil correlation	FAO/UNESCO Eutric Planosol	USDA Soil Taxonomy Haplaqualf

Described: 25.7.1989

Location: Bound to Shine farm (16Q CQ 346 955)

Landform: 1 degree north-east-facing upper slope on very gently undulating plain in Lazaro Plain land system

Parent Material: Thick siliceous wash over Tower Hill Formation limestone

Vegetation: Young citrus and plantain in guinea grass

Site Drainage: Good

Surface: 0 – 3cm discontinuous litter of guinea grass. Very worn old ridging microrelief.

Sample no.	Depth (cm)	
0Z 1/1	0-17	2.5Y N3 (very dark grey); loamy quartz sand; weak subangular blocky breaking to single grain; few medium pores; moist-dry and slightly friable; many fine roots decreasing to common; clear regular boundary to:
	17-39	10YR 5/2 (greyish brown) with common medium very faint pale brown and few very fine very faint reddish brown mottles; loamy medium sand; extremely weak medium angular blocky easily breaking to single grain; moist and very friable; few fine pores; few fine roots, rare fine rounded quartz gravel; gradual regular boundary to:
0Z 1/2	39-61/84	2.5Y 6/2 (light brownish grey) with many medium faint reddish-yellow fine mottles; medium sand; single grain; moist and extremely friable-loose; few fine pores; few fine roots; contains isolated pockets of stiff brown sandy-clay from horizon below; abrupt very wavy-pocketed boundary to:
0Z 1/3	61/84-102	10YR 5/4 (yellowish brown) with 10YR 4/2 (dark greyish brown) coatings on peds, and interior mottles of reddish-yellow and red (these slightly indurated and concretionary); sandy clay; weak coarse subangular blocky-massive with moderate continuous dark clayskins; many medium pores; moist and very firm; few fine live roots and few coarse old darkened root channels; common quartz grit; gradual regular boundary to:
	102-120	As above but fewer dark organic coatings; gradual regular boundary to:
0Z 1/4	120-140	2.5Y 6/4 (light yellowish brown) with many medium distinct reddish-yellow mottles (not red or concretionary); clay with patches of sandy clay; weak coarse subangular blocky to massive with continuous brown clayskins; few medium pores; rare fine live roots and few medium darkened old root channels.
Continued by auger		
	140-160	As above
	160+	Creamy soft sascab with bright yellow colours at top.

Note: The extremely high P levels have been rechecked and are not experimental errors. They may be due to corprolitic layers in the limestone.

Depth (cm)	Lab no.	Particle size class: Sand – Coarse	Sand – Medium	Sand – Fine	Sand – Very fine	Silt – Coarse	Silt – Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-17	9030	8	23	30	18	5	4	12	7.7	7.1	0.12	2.2	0.18	2.11	12	800	66	1.22
39-61/84	9031	13	30	31	17	5	1	3	7.4	6.8	0.05	0.2	0.01	0.08	8	63	21	1.61
61/84-102	9032	6	18	26	15	4	1	30	6.9	5.7	0.06	3.0	0.03	0.16	5	7	2	1.23
120-140	9033	2	8	13	26	3	4	44	6.4	5.1	0.06	5.1	0.03	0.09	3	2,905	36	1.22

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. – Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) – P	K	Mg	Ca	Trace elements (ppm) – Cu	Mn	Zn	% $CaCO_3$
0-17	9030	0.1	1.1	2.7	19.2	–	23.1	17.2	100	1,280	950	1,300	6,300	20	140	40	0.0
39-61/84	9031	0.0	0.1	0.3	1.8	–	2.2	1.9	100	100	50	100	300	<5	10	<5	–
61/84-102	9032	0.1	0.1	1.7	11.7	–	13.6	14.1	96	310	406	1,600	2,150	<5	20	10	–
120-140	9033	0.2	0.2	1.8	23.6	–	25.8	26.0	99	5,020	750	3,700	14,050	<5	30	20	–

Soil Classification	Suite Pembroke	Subsuite Louisville
Soil correlation	FAO/UNESCO Rendzic Cambisol	USDA (Soil Taxonomy) Rendollic Eutropept
Described:	25.7.1989	
Location:	Tower Hill Road, 3 km west of Bound to Shine (16Q CQ 293 966)	
Landform:	Upper slope on slightly convex rise in very gently undulating plain in Shipyard Plain land system. 1 degree down to east	
Parent Material:	Limestone	
Vegetation:	Abandoned cane	
Site Drainage:	Good	
Surface:	Discontinuous cane litter. Very worn ridges	

Sample no.	Depth (cm)	
0Z 2/1	0-14	10YR 3/1 (very dark grey); clay loam; moderate medium subangular blocky (fine crumb 0-6cm); common medium pores; moist and firm but friable at surface; many medium roots; few fragments of limestone; clear regular boundary to:
0Z 2/2	14-30/35	10YR 5/1 (grey); clay; moderate medium subangular blocky with weak discontinuous clayskins; common medium pores; moist and firm, plastic, slightly sticky; common medium roots; few fragments of limestone; abrupt slightly wavy boundary to:
	30/35-54	Mixed 10YR 5/2 (greyish brown) and 10YR 7/2 (light grey); sascab (silty loam texture) with patches of harder limestone; common medium pores; moist and friable; common medium roots; abrupt regular boundary to:
	54-74+	10YR 8/3 (very pale brown); slightly hard limestone with hard pale brown fine grained nodules, especially near top; rare roots.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-14	9034	2	9	17	8	3	9	52	8.0	7.2	0.12	8.9	0.40	4.17	10	84	5	0.96
14-30/35	9035	4	9	19	8	3	5	52	8.1	7.2	0.13	8.0	0.15	0.81	5	9	2	1.09

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-14	9034	0.3	0.2	3.6	>50.0	–	>54.1	57.0	100	320	850	6,400	16,750	10	530	30	1.0
14-30/35	9035	0.2	0.2	2.8	>50.0	–	>53.2	48.8	100	100	600	6,050	12,460	>5	430	30	1.0

Soil Classification	Suite Guinea Grass	Subsuite Lazaro
Soil correlation	FAO/UNESCO Eutric Cambisol	USDA Soil Taxonomy Typic Eutropept

Described:	25.7.1989
Location:	1.5 km south of Yo Creek (16Q CQ 257 995)
Landform:	1/2 degree upper slope on very gently undulating plain in Lazaro Plain land system
Parent Material:	Tower Hill Formation limestone, with some siliceous sand wash
Vegetation:	Young cane
Site Drainage:	Good
Surface:	Mostly bare, with some ridging up

Sample no.	Depth (cm)	
0Z 3/1	0-15	10YR 3/1 (very dark grey); very fine sandy-silty clay loam; weak medium subangular blocky breaking to moderate fine crumb; common fine pores; moist and friable; common medium roots; many worms; clear regular boundary to:
0Z 3/2	15-29	10YR 4/1 (dark grey); very fine sandy clay-clay; moderate to weak medium subangular blocky with moderate discontinuous clay skins; many fine pores; moist and slightly friable, plastic but not sticky; common medium roots; clear regular boundary to:
	29-90	10YR 8/2 (white) with few medium distinct reddish yellow mottles; gritty sascab (clay loam texture); massive; few fine pores; moist and firm; few medium roots; gradual regular boundary to:
	90-120+	10YR 8/3 (very pale brown); with many coarse distinct reddish-yellow mottles; sascab (clay loam); massive; moist-wet and slightly firm; no roots.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-15	9036	1	7	28	18	8	6	32	8.1	7.4	0.12	5.3	0.17	1.70	10	15	3	1.16
14-30/35	9037	1	7	25	18	8	5	36	7.8	6.5	0.10	5.6	0.08	0.54	7	4	1	1.20

		Exchangeable cations me/100 g a.d.s.								Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-14	9036	0.0	0.2	2.1	42.3	–	44.6	36.2	100	110	500	4,600	9,000	<5	190	20	0
15-29	9037	0.1	0.1	1.8	35.8	–	37.8	37.2	100	60	500	4,850	6,800	<5	130	20	0

Soil Classification	Suite Revenge	Subsuite Felipe
Soil correlation	FAO/UNESCO Eutric Planosol	USDA Soil Taxonomy Typic Albaqualf

Described: 26.7.1989

Location: 0.5 km north of Chan Pine Ridge village (16Q CQ 328 951)

Landform: Flat area of undulating plain in San Felipe Plain land system

Parent Material: Deep siliceous drift (? over Tower Hill Formation limestone)

Vegetation: Coppice weed growth in semi-abandoned pasture. Nearby hedge includes trumpet and botans

Site Drainage: Imperfect

Surface: 0-1 cm discontinuous grass litter

Sample no.	Depth (cm)	
0Z 4/1	0-6	10YR 3/1 (very dark grey); with common paler patches; medium sandy loam-loamy sand; weak medium subangular blocky breaking to weak medium crumb; common fine pores; moist and friable; abundant fine roots; gradual regular boundary to:
	6-16	7.5YR 4/2 (brown-dark brown) with many medium faint yellowish brown mottles; loamy medium sand; weak medium crumb breaking to single grain; common medium pores; moist and extremely friable; common fine roots; clear regular boundary to:
OZ 4/2	16-40/46	10YR 7/3 (very pale brown) with many medium prominent yellowish red and orange mottles; medium sandy clay loam; weak medium-coarse subangular blocky; few clayskins on root channels; moist-wet, slightly plastic and slightly sticky; abundant fine pores; common fine roots; clear very wavy boundary to:
	40/46-50/55	(almost discontinuous in places) As above but many fewer mottles and slightly coarser texture; clear wavy boundary to:
0Z 4/3	50/55-110	7.5YR 5/2 (brown); sandy clay loam with common vertical channels of 10YR 7/3 (very pale brown) coarse sandy loam; massive with weak discontinuous clayskins on some parting faces; moist (much drier than above), extremely firm and compact; few fine pores; rare fine roots (not concentrated in coarser channels).
Continued by auger		
	110-140	As above
	140-170+	As above but slightly coarser texture.

Note: Vertical coarser inclusions below 50/55 cm may be infillings of old pine tap root channels. Note importance of Na^+ in exchangeable cations (ESP = 37% in subsoil).

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-6	9038	3	13	47	24	5	2	6	6.9	6.4	0.13	0.8	0.11	1.17	11	5	3	1.32
16-40/46	9039	5	16	34	15	4	2	24	6.2	4.3	0.08	2.3	0.03	0.18	6	3	2	1.13
50/55-110	9040	2	13	35	14	5	4	27	7.8	5.7	0.30	2.5	0.03	0.09	3	4	1	1.24

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-6	9038	0.2	0.0	0.9	4.9	-	6.0	6.0	100	120	100	350	1,300	<5	20	<5	0.0
16-40/46	9039	1.6	0.0	1.8	6.6	-	10.0	11.8	85	90	200	1,350	1,300	<5	20	10	-
50/55-110	9040	5.7	0.1	2.1	7.7	-	15.6	15.5	100	80	250	1,950	1,400	<5	20	10	-

Soil Classification	Suite Guinea Grass	Subsuite Lazaro
Soil correlation	FAO/UNESCO Gleyic Luvisol	USDA Soil Taxonomy Hapludalf

Described: 27.7.1989

Location: 1.5km north of San Lorenzo on San Roman road (16Q CR 288 079)

Landform: 1 degree west-facing upper slope on low rise in gently undulating plain in Lazaro Plain land system

Parent Material: Siliceous drift over Tower Hill Formation sascab

Vegetation: Low secondary bush with chucum and botan

Site Drainage: Good

Surface: 0-1cm litter

Sample no.	Depth (cm)	
0Z 5/1	0-13	10YR 2/1 (black); very fine sandy clay-clay; moderate-weak fine subangular blocky; common fine pores; moist and friable, slightly plastic, non-sticky; many fine and medium roots; gradual regular boundary to:
	13-33	10YR 4/1 (dark grey); fine sandy clay; moderate medium subangular blocky with weak discontinuous clayskins – pressure faces; many fine pores; moist and slightly firm, slightly plastic, very slightly sticky; many medium roots; diffuse boundary to:
0Z 5/2	33-56	10YR 5/2 (greyish brown); with common medium faint yellowish brown and light grey mottles; fine sandy clay; moderate medium subangular blocky with moderate discontinuous clay skins; common fine pores; moist and firm; few medium roots; gradual regular boundary to:
OZ 5/3	56-100	2.5Y 8/2 (white); with many fine linear prominent reddish brown mottles; fine sandy clay-clay loam; weak medium subangular blocky – massive with moderate discontinuous clayskins; few fine pores; moist and extremely firm; rare fine roots; diffuse boundary to:
	100-120+	10YR 8/1 (white); with many common medium faint yellow and pale yellow mottles; gritty sascab (clay texture); moist and friable-crumbly; rare fine roots.

Note: Despite the low pH and the presence of exchangeable Al, this soil is virtually base-saturated, with Ca as the main exchangeable cation.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-13	9041	1	8	32	19	9	5	26	6.5	5.6	0.11	3.9	0.25	1.93	8	6	–	1.15
33-56	9042	1	7	27	17	7	4	37	5.5	3.9	0.06	5.6	0.03	0.19	6	5	–	1.15
56-100	9043	1	6	26	16	6	4	41	5.1	4.1	0.14	6.6	0.01	0.13	13	5	–	1.17

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-13	9041	0.2	0.1	3.2	26.5	0.0	30.0	30.8	97	210	150	2,550	5,000	10	110	10	–
33-56	9042	0.3	0.0	2.5	24.2	1.1	27.0	30.5	89	120	250	3,900	4,400	<5	30	30	–
56-100	9043	0.7	0.1	2.4	28.7	0.4	31.9	32.1	99	110	300	4,650	5,550	<5	40	30	–

Soil Classification	Suite Tintal	Subsuite Pucte
Soil correlation	FAO/UNESCO Gleyic or Vertic Cambisol	USDA Soil Taxonomy Aquoll

Described: 27.7.1989

Location: 1 km south-east of Douglas village (16Q CR 321 161)

Landform: Level area on lower slope in Lazaro Plain land system plain

Parent Material: Tower Hill Formation limestone

Vegetation: Low secondary bush-pasture with *Bactris* palms, hogplum and chucum

Site Drainage: Poor; rapid filling of pit by subsoil throughflow

Surface: 3-5 cm of fibrous litter. Slight hogwallow microrelief

Sample no.	Depth (cm)	
0Z 6/1	0-16	5YR 3/1 (very dark grey); clay; strong medium angular blocky with moderate continuous pressure coatings; common fine pores; moist and firm; common medium and many fine roots; common fine pores; moist and firm; common fine shell fragments; clear regular boundary to:
0Z 6/2	16-51	5YR 6/1 (light grey to grey) with common medium very faint white mottles; clay; moderate medium subangular blocky with moderate continuous clayskins; many fine pores; moist and firm, plastic and slightly sticky; common medium roots; common fine shell fragments; gradual regular boundary to:
	51-80	5YR 6/1 (light grey to grey) with common patches of 10YR 6/2 (light greyish brown) sascab (clay texture); moderate medium subangular blocky with strong continuous clayskins and moisture films; many fine pores; wet, plastic and sticky; few medium roots; gradual regular boundary to:
OZ 6/3	80-120+	Colours as above but sascab patches abundant; clay; weak coarse subangular blocky with moderate discontinuous clayskins; many fine pores; moist, plastic and slightly sticky; few darkened old root channels; sascab contains few fragments of harder limestone.

Note: This pit filled rapidly through numerous voids at depth 70-80 cm. Water was milky and smelt sulphidic. Although not highly mottled, it appears to just qualify as a colluvial swamp margin soil of Pucte Subsuite.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm^3 a.d.s.
0-16	9044	1	3	11	12	6	8	59	8.1	7.3	0.47	10.8	0.19	1.56	8	44	3	1.11
16-51	9045	3	2	8	7	4	13	63	8.3	7.5	0.61	8.5	0.04	0.33	8	3	2	1.11
80-120	9046	3	3	8	8	4	12	62	8.6	7.5	0.23	8.1	0.03	0.26	9	1	2	1.15

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			%
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	$CaCO_3$
0-16	9044	2.1	0.7	12.3	>50.0	–	>65.1	59.4	100	430	2,700	12,300	31,350	10	330	40	4.5
16-51	9045	1.5	0.4	14.7	>50.0	–	>66.6	45.1	100	240	2,300	11,900	132,500	10	230	40	28.5
80-180	9046	0.8	0.4	13.3	>50.0	–	>64.5	40.9	100	170	2,250	11,100	156,600	10	180	30	32.5

Soil Classification	Suite Pembroke	Subsuite Concepcion
Soil correlation	FAO/UNESCO Eutric or Vertic Cambisol	USDA Soil Taxonomy Rendollic Eutropept
Described:	28.7.1989	
Location:	Maya road, 0.5 km north of the Northern Highway (16Q CR 422 264)	
Landform:	Flat area on gently undulating plain in Louisville Plain land system	
Parent Material:	Orange Walk Group limestone	
Vegetation:	Young cane	
Site Drainage:	Good	
Surface:	Common limestone fragments, microrelief from ridging of cane	

Sample no.	Depth (cm)	
0Z 7/1	0-12	5YR 3/2 (dark reddish brown); clay; medium fine crumb; moist and very friable – wet and slightly plastic and very slightly sticky; many fine roots; common very fine pores; common worms; diffuse boundary to:
0Z 7/2	12-38	5YR 4/2 (dark reddish grey); clay; moderate fine subangular blocky with continuous moisture films and clayskins; few fine pores; moist and friable – slightly wet and slightly plastic and very slightly sticky; common patches of charcoal; few fine hard limestone fragments; clear slightly wavy boundary to:
	38-60+	Densely packed rubble of medium fairly hard creamy limestone with thin interstitial layers as above; common fine roots.

Note: The K levels, both exchangeable and total, are quite high.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-16	9047	0	1	2	1	2	10	84	8.0	7.3	0.17	14.0	0.44	3.54	8	21	3	1.01
12-38	9048	0	1	2	0	3	8	86	7.8	7.0	0.17	14.1	0.40	2.86	7	7	2	1.01

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-12	9047	0.2	1.4	4.3	>50.0	–	>55.9	74.4	–	280	8,900	8,200	19,750	20	760	50	0.5
12-38	9048	0.2	1.2	3.3	>50.0	–	>54.7	72.6	–	210	8,700	8,000	16,650	20	810	60	0.5

Soil Classification		Suite Pembroke	Subsuite Xaibe
Soil correlation		FAO/UNESCO Chromic Cambisol	USDA Soil Taxonomy Rhodudalfic Eutropept
Described:		28.7.1989	
Location:		1.5 km west of San Joaquin (16Q CR 464 302)	
Landform:		Flat area in higher part of gently undulating plain in Xaibe Plain land system	
Parent Material:		Orange Walk Group limestone	
Vegetation:		Guinea grass on edge of young cane	
Site Drainage:		Good	
Surface:		Discontinous grass litter	

Sample no.	Depth no (cm)	
0Z 8/1	0-16	5YR 3/3 (dark reddish brown); stony clay; moderate fine subangular blocky breaking to moderate medium crumb; common fine pores; moist and friable; many fine roots; many fragments of hard and slightly hard limestone; common fine fragments of charcoal; common ants; gradual boundary to:
0Z 8/2	16-45	2.5Y 3/4 (dark reddish brown) moist, 2.5YR 4/4 (reddish brown) dry; very stony clay; stony structure with interstitial moderate fine subangular blocky with weak discontinuous clayskins; moist and stony – very firm; few fine roots; abundant stones as above; abundant ants; gradual regular boundary to:
	45-72	Discontinuous horizon of 5YR 6/6 (reddish yellow); friable crumbly sascab (silty clay loam texture); few fine roots; abrupt slightly wavy boundary to:
	72-110+	7.5YR 8/6 (reddish yellow); dense soft limestone.

Note: Hard limestone in upper horizons are thought to be remnants of old carapace.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm^3 a.d.s.
0-16	9049	13	4	6	4	4	15	54	8.2	7.6	0.16	6.2	0.38	3.07	8	17	5	0.97
16-45	9050	21	5	5	4	3	19	43	8.4	7.7	0.15	3.9	0.20	1.32	7	1	3	0.97

		Exchangeable cations me/100 g a.d.s.						Cation									
							TEB me %	exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			%
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	$CaCO_3$
0-16	9049	0.2	1.5	2.8	>50.0	–	>54.5	33.3	100	480	7,850	5,650	141,700	20	530	30	30.5
16-45	9050	0.1	0.5	1.3	>50.0	–	>51.9	19.3	100	170	4,750	4,250	214,900	10	310	20	54.0

Soil Classification	Suite Guinea Grass	Subsuite Lazaro
Soil correlation	FAO/UNESCO Eutric Cambisol	USDA Soil Taxonomy Typic Eutropept

Described: 30.7.1989

Location: 3 km south-east of San Lorenzo (16Q CR 299 039)

Landform: Upper slope of low rise, with slope 2 degrees down to NNE on undulating plain in Lazaro Plain land systems

Parent Material: Fairly hard Tower Hill Formation limestone with siliceous drift

Vegetation: Dense low secondary bush with few trumpet trees

Site Drainage: Very good

Surface: 4 cm leaf and twig litter

Sample no.	Depth (cm)	
0Z 9/1	0-14	10YR 3/1 (very dark grey); fine sandy loam-sandy clay loam; weak medium subangular blocky breaking to moderate fine crumb; many fine and medium pores; moist and very friable; abundant medium and fine roots; many fine white grains (?quartz); non-calcareous; clear regular boundary to:
0Z 9/2	14-45	7.5YR N3 (very dark grey); fine sandy clay; moderate medium subangular blocky with few discontinuous weak to moderate clay skins; common fine pores; few medium and common fine roots; moist and friable-slightly firm; many fine white quartz grains and few rounded quartz grit; non-calcareous; abrupt regular boundary to:
	45-68+	10YR 8/2 (white); fairly hard limestone with common medium very faint pale yellow patches; few fine roots.

Note: Boundary between quartzose drift and underlying limestone is extremely sharp. Although the drift is non-calcareous, it is shallow enough to enable considerable biological recycling of Ca, which dominates the exchangeable cations and gives full base saturation and a neutral reaction.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-14	9075	2	12	38	21	8	3	16	6.9	6.5	0.20	3.1	0.27	2.17	8	10	5	1.16
14-45	9076	3	10	32	19	10	3	23	7.5	6.5	0.10	3.6	0.09	0.62	7	5	1	1.12

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-14	9075	0.1	0.2	3.8	21.2	-	25.3	24.3	100	300	200	1,950	4,450	10	70	20	0
14-45	9076	0.1	0.0	1.8	22.1	-	24.0	21.8	100	160	200	2,400	4,550	10	50	20	0

Soil Classification	Suite Guinea Grass	Subsuite Lazaro
Soil correlation	FAO/UNESCO Haplic Luvisol	USDA Soil Taxonomy Typic Hapludalf

Described: 30.7.89

Location: 4 km north-west of Trial Farm, Orange Walk (16Q CR 309 029)

Landform: Gentle upper slope of low rise in undulating plain in Lazaro Plain land system

Parent Material: Siliceous drift over soft Tower Hill Formation limestone

Vegetation: Young cane

Site Drainage: Slightly impeded

Surface: Discontinuous cane trash; cane is ridged up

Sample no.	Depth (cm)	
0Z 10/1	0-13	2.5Y N3 (very dark grey); silty clay loam; moderate fine subangular blocky breaking to moderate medium crumb; moist, slightly friable; few medium pores; many medium and fine roots; worms; many fine white (?) quartz grains; non-calcareous; gradual regular boundary to:
0Z 10/2	13-32/44	7.5YR N3 (very dark grey); very fine sandy clay loam; moderate medium angular to subangular blocky with moderate discontinuous coatings; many fine and medium pores; moist and friable; slightly plastic; non-sticky; many medium fine roots; common white fine quartz grit; non-calcareous; gradual wavy boundary to:
	32/44-46/65	10YR 5/1 (grey) with many fine and medium faint pale yellow and pale brown and fine distinct reddish yellow mottles; medium sandy clay; moderate medium subangular blocky with moderate discontinuous clayskins; few medium pores; moist and slightly firm, slightly plastic, non-sticky; few fine roots; common fine quartz grains; non-calcareous; diffuse boundary to:
OZ 10/3	46/65-115	10YR 8/3 (very pale yellow) with common fine distinct reddish-brown and reddish yellow linear mottles and common medium very faint pale yellow mottles; fine sandy clay; weak to moderate coarse blocky with moderate continuous clayskins; many very fine pores; few fine roots; common soft black-dark brown ferrimanganiferous patches; moist, slightly firm, slightly plastic, non-sticky; non-calcareous; diffuse boundary to:
0Z 10/4	115-135+	Mixed 2.5Y 8/2 (white) and 10YR 8/4 (very pale brown) with abundant medium distinct reddish yellow mottles; clay; massive breaking to weak fine angular blocky with moderate continuous clayskins; few fine pores; moist and firm, slightly plastic; rare fine roots; common fine soft to slightly hard fragments of limestone; calcareous; few medium black to dark brown ferrimanganiferous patches.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-13	9077	1	9	36	21	8	5	20	7.0	6.5	0.09	4.1	0.33	3.00	9	16	3	1.10
13-32/44	9078	2	9	34	23	7	4	21	7.4	6.5	0.07	3.7	0.13	1.01	8	4	2	1.15
46/65-115	9079	2	8	30	16	7	4	33	6.5	4.9	0.04	5.8	0.01	0.12	12	3	1	1.19
115-135	9080	2	4	16	9	5	24	40	8.6	7.6	0.12	6.8	0.02	0.10	5	2	2	1.23

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-13	9077	0.0	0.1	3.3	30.0	–	33.4	31.7	100	220	150	2,150	5,850	10	190	20	0
13-32/44	9078	0.1	0.1	2.6	21.8	–	24.6	22.8	100	130	100	2,350	4,106	<5	146	20	0
46/65-115	9079	0.2	0.1	2.4	25.4	–	28.1	28.2	100	70	250	3,900	4,650	<5	90	30	0
115-135	9080	0.2	0.1	2.8	>50.0	–	>53.1	33.8	100	80	350	6,000	95,050	10	340	30	21.0

Soil Classification	Suite Yaxa	Subsuite Jolja
Soil correlation	FAO/UNESCO Skeletal Eutric Cambisol	USDA Soil Taxonomy Skeletal Typic Rendoll
Described:	31.7.89	
Location:	Bedraan Ranch (16Q BQ 749 808)	
Landform:	Dry valley floor in undulating plain in Blue Creek Plain land system	
Parent Material:	Barton Creek Formation limestone with flints	
Vegetation:	Logged, low semi-deciduous forest	
Site Drainage:	Imperfect-good	
Surface:	Rare medium flints, 2-4 cm continuous leaf litter	

Sample no.	Depth (cm)	
0Z 11/1	0-8	10YR 2/1 (black); loam; moderate medium breaking to fine subangular blocky; common fine subangular blocky; common fine pores; moist and slightly firm; common medium and many fine roots; worms; non-calcareous; clear regular boundary to:
	8-26	10YR 4/1 (dark grey); clay; moderate medium subangular blocky; common medium pores; moist and firm, plastic, slightly sticky; few medium fine roots; few medium flints; common white very fine grains; non-calcareous; gradual regular boundary to:
OZ 11/2	26-47	10YR 5/1 (grey); massive to weak medium angular blocky; common fine pores; moist-wet, firm, very plastic, sticky; few medium and fine roots; few flints; few soft black manganiferous concretions; few fine white quartz grains; non-calcareous; gradual regular boundary to:
OZ 11/3	47-75	N4 (dark grey) with few fine distinct reddish yellow mottles; stony clay; massive to moderate medium angular blocky with strong continuous striated pressure faces; no pores; moist and extremely firm; few medium and rare coarse roots; many rounded and angular flints; non-calcareous; gradual slightly wavy boundary to:
	75-95	10YR 7/2 (light grey) with many medium distinct dark grey and very pale brown mottles; extremely stony clay; structure dominated by stones with moderate fine angular blocky in interstitial clay; few medium pores; moist and indurated (stony); few fine roots; abundant flint and jaspers; common black soft manganese concretions; non-calcareous; abrupt regular boundary to:
	95-97	Discontinuous black ferrimanganese pan.
	97-105+	10YR 8/1 (white) limestone with few medium faint very pale brown patches.

Note: Although quite acid, the upper horizons are highly base-saturated. The high total Mg contents suggest that the parent material is dolomitic. The presence of manganiferous concretions confirms the high total Mn figures.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-8	9081	4	5	6	4	8	18	55	6.4	5.7	0.15	10.4	0.52	4.76	9	5	–	0.96
26-47	9082	9	4	5	4	5	16	57	5.5	3.8	0.06	11.0	0.13	0.95	7	4	–	1.02
47-75	9083	11	4	4	3	5	12	61	5.1	3.3	0.09	11.8	0.04	0.31	8	3	–	1.02

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-8	9081	0.4	0.5	9.0	45.8	0.0	55.7	58.0	96	200	350	7,350	9,200	10	1,390	40	–
26-47	9082	1.2	0.1	8.3	32.5	1.2	42.1	50.3	84	60	200	8,250	6,050	10	2,370	40	–
47-75	9083	2.0	0.1	8.6	35.0	2.8	45.7	53.7	85	30	200	8,850	6,800	10	350	40	–

Soil Classification	Suite Yaxa	Subsuite Jolja
Soil correlation	FAO/UNESCO Eutric Leptosol	USDA Soil Taxonomy Skeletal Eutropept
Described:	31.7.89	
Location:	Bedraan Ranch (16Q BQ 769 809)	
Landform:	3 degrees north-east-facing upper slope in undulating plain in Blue Creek Plain land system	
Parent Material:	Barton Creek Formation limestone with flints	
Vegetation:	Recently cleared forest with many sapote, santa maria, mahogany and other secondary timbers in low herbaceous secondary vegetation	
Site Drainage:	Good	
Surface:	Common flints in very discontinuous grass litter	

Sample no.	Depth (cm)	
0Z 12/1	0-14	N3 (very dark grey); stony clay; moderate fine subangular blocky; common fine pores; moist and slightly friable; many fine and medium roots; common fine and medium rounded quartz; many worms, larvae, etc; gradual regular boundary to:
OZ 12/2	14-29	10YR 3/1 (very dark grey); very stony clay; stony structure with moderate-fine subangular blocky in interstitial clay, with weak discontinuous clayskins against stones; many fine pores; moist and friable; common, medium and fine roots; abundant flints and jaspers up to 8 cm diameter; clear regular boundary to:
	29-60+	Creamy limestone, hard at top but becoming slightly soft at depth; no roots.

Note: Limestone appears to be dolomitic. The K and Mg contents are high.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-14	9084	8	5	4	3	5	11	64	7.8	7.2	0.27	11.9	0.68	5.29	8	45	7	0.91
14-29	9085	39	4	4	1	3	6	43	8.1	7.2	0.17	9.2	0.35	3.00	9	13	3	1.05

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-14	9084	0.1	3.0	7.0	>50.0	–	>60.1	66.3	>90	390	3,400	13,000	37,750	20	480	60	4.5
14-29	9085	0.0	1.0	4.4	>50.0	–	>55.4	48.8	100	130	1,800	9,300	19,550	10	220	40	2.5

Soil Classification	Suite Puletan	Subsuite Boom
Soil correlation	FAO/UNESCO Eutric Planosol	USDA Soil Taxonomy Tropaquult

Described: 1.8.89

Location: 2 km north-east of August Pine Ridge (16Q CQ 184 898)

Landform: Very slight elevated flat area in gently undulating plain in August Pine Plain land system

Parent Material: Deep siliceous old alluvium over Tower Hill Formation limestone

Vegetation: Pine ridge with few large pines (*Pinus caribaea*) and palmetto and small craboo

Site Drainage: Imperfect (shallow sub-surface throughflow)

Surface: Slight microrelief in wet areas just down slope

Sample no.	Depth (cm)	
0Z 13/1	0-9	10YR 4/1 (dark grey) with common medium very faint grey mottles; coarse sand-loamy sand; very weak fine subangular blocky breaking to singlegrain; moist and very friable-loose; many fine and common medium roots; clear regular boundary to:
	9-15	10YR 6/3 (pale brown) with common fine distinct reddish brown and common medium faint brownish yellow mottles; coarse sand to loamy sand; very weak fine subangular blocky breaking to single grain; moist and friable-loose; many fine and common medium roots; clear regular boundary to:
OZ 13/2	15-36	10YR 6/4 (light yellowish brown) with few very fine faint reddish yellow mottles; sandy loam; weak medium breaking to fine subangular blocky; common fine pores; moist to wet, very friable-loose; common fine and medium roots; few angular quartz grit and rare rounded quartz pebbles; clear regular boundary to:
OZ 13/3	36-120	10YR 6/3 (pale brown); fine sandy clay loam; moderate coarse angular blocky with moderate discontinuous clayskins; few medium pores; moist and firm; few medium and fine roots; many very fine black ferrimanganiferous concretions; common fine subangular quartz grit; clear regular boundary to:
	120-150+	10YR 6/3 (pale brown) with many medium prominent orange, red and dark brown mottles, especially concentrated in upper 20 cm; extremely stony sandy clay loam; stony structure with discontinuous moisture films; moist and slightly firm; rare fine roots; abundant fine sandstone fragments with sugary partings:
Continued by auger		
	150-220	As above
	220-240+	Very pale yellow; moist, very plastic and slightly sticky clay with many coarse prominent red mottles.

Note: Although no limestone was found in the top 2.5 m, there is sufficient exchangeable Ca in most of this profile to give high base saturation of the limited exchange capacity. The organic matter levels and contents of nitrogen and phosphorus are very low.

ANALYSIS

NORTH BELIZE 1989-1990

PROFILE OZ 13

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-9	9086	1	10	48	30	6	2	3	6.2	5.4	0.06	0.4	0.05	0.60	12	2	–	1.30
15-36	9087	5	13	33	19	6	2	22	5.1	4.1	0.06	1.7	0.04	0.23	6	2	–	1.20
80-100	9088	3	11	33	17	8	3	25	4.7	3.9	0.18	1.9	0.03	0.05	~2	2	–	1.25

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-9	9086	0.0	0.1	0.3	2.7	0.0	3.1	3.2	97	20	50	100	300	<5	10	<5	–
15-36	9087	0.1	0.1	0.7	2.6	2.4	3.5	6.5	54	40	200	700	350	<5	10	10	–
80-100	9088	0.5	0.1	0.7	6.0	1.2	7.3	8.1	90	30	200	850	1,000	10	20	10	–

Soil Classification	Suite Puletan	Subsuite Boom
Soil correlation	FAO/UNESCO Eutric or Dystic Planosol	USDA Soil Taxonomy Tropaquult or Tropaqualf

Described:	2.8.89
Location:	1.5 km WSW of San Felipe (16Q CQ 108 765)
Landform:	High flat area in gently undulating plain in August Pine Plain land system
Parent Material:	Deep siliceous old alluvium
Vegetation:	Pine ridge with palmetto, craboo and few pines and common grass cover, currently grazed
Site Drainage:	Imperfect to good
Surface:	No litter

Sample no.	Depth (cm)	
0Z 14/1	0-5	10YR 4/1 (dark grey) with abundant bleached quartz grains; medium sand-loamy sand; single grain; moist and extremely friable; many fine and medium roots; clear regular boundary to:
	5-13	10YR 8/3 (very pale brown) with common medium faint brown mottles and common fine black mottles at base; medium sand to loamy sand; very weak fine angular blocky breaking to single grain; moist and very friable; few fine roots; clear regular boundary to:
	13-23	10YR 5/4 (yellowish brown) grading to 10YR 7/4 (very pale brown) with common fine black patches; loamy medium sand; very weak angular blocky breaking to single grain; moist to wet, friable; common medium and fine roots; gradual regular boundary to:
0Z 14/2	23-45	10YR 8/2 (white) with rare fine black mottles; medium sand; single grain; moist and extremely friable; few fine roots; clear slightly wavy boundary to:
0Z 14/3	45-83	7.5YR 7/4 (pink) with common medium prominent orange and reddish brown mottles; medium sandy clay loam; moderate medium angular blocky with weak discontinuous clayskins; many coarse, medium and fine pores; moist and slightly firm; few fine roots; few fine angular quartz grit; diffuse boundary to:
OZ 14/4	83-147	7.5YR 6/4 (light brown) with mottles as above horizon but only at top; medium sandy clay (also lenses of 10YR 7/6 (yellow) sandy loam); moderate to strong coarse angular blocky with moderate continuous clayskins; few fine pores; moist and firm; rare fine roots; clear regular boundary to:
	147-165+	Material as above but extremely indurated to form massive sandstone.

Note: Upper horizons are extremely dystrophic, especially the white sand at 23-45 cm, which contains virtually no nutrients in any form.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-5	9019	3	24	52	15	3	1	2	5.1	4.0	0.09	0.6	0.13	1.36	10	2	–	1.28
23-45	9020	4	20	43	23	7	2	1	5.5	4.6	0.03	0.1	0.01	0.06	6	0	–	1.49
45-83	9021	2	12	22	14	9	4	37	5.4	3.7	0.05	3.0	0.04	0.09	~2	1	–	1.25
83-147	9022	2	12	26	16	8	4	32	5.3	3.6	0.05	2.2	0.04	0.07	~2	1	–	1.29

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-5	9019	0.2	0.1	0.3	1.3	0.1	1.9	3.4	56	40	50	100	250	<5	10	<5	–
23-45	9020	0.0	0.0	0.0	0.2	0.2	0.2	0.4	50	10	<25	50	<25	<5	<5	<5	–
45-83	9021	0.4	0.0	2.2	7.8	0.6	10.4	12.5	83	40	300	1,400	1,400	10	20	20	–
83-147	9022	0.5	0.1	1.7	7.2	0.3	9.5	10.8	88	30	250	1,150	1,300	<5	20	10	–

Soil Classification	Suite Yaxa	Subsuite Yalbac
Soil correlation	FAO/UNESCO Pelli-eutric Vertisol	USDA Soil Taxonomy Typic Pelludert
Described:	2.8.89	
Location:	2 km south-east of San Felipe (16Q CQ 136 753)	
Landform:	Upper part of low flat rise in gently undulating plain in Shipyard Plain land system, with 1 degree slope to south-east	
Parent Material:	Limestone	
Vegetation:	Low secondary herbaceous regrowth after beans and corn, which were harvested in April	
Site Drainage:	Good	
Surface:	1 cm of herbaceous litter	

Sample no.	Depth (cm)	
0Z 15/1	0-9	10YR 3/1 (very dark grey); clay; moderate fine crumb; many fine pores; moist and friable; common fine roots, few white non-calcareous grains; clear regular boundary to:
OZ 15/2	9-48	10YR 3/1 (very dark grey) with common medium faint grey mottles; clay; moderate medium subangular blocky with common discontinuous clayskins; many fine pores; moist and slightly firm, slightly plastic but non-sticky; few fine roots; rare fragments of iron-coated sandstone; common very fine black ferrimanganese concretions; gradual regular boundary to:
OZ 15/3	48-86	10YR 4/1 (dark grey) with common, very fine and very faint reddish brown mottles; clay; moderate coarse breaking to moderate medium angular blocky with moderate discontinuous clayskins; many fine and medium pores; moist-wet, plastic and slightly sticky; few fine white grains; gradual regular boundary to:
0Z 15/4	86-125	10YR 6/1 (light grey) with few very coarse patches of 2.5Y 7/2 (light grey (calcareous, moist and friable)); clay; moderate coarse lenticular with strong continuous slickensides; many fine pores; moist and very firm; rare fine roots; many soft white calcareous concretions in pale patches; clear slightly wavy boundary to:
	125-150+	2.5Y 7/2 (light grey) with few medium faint yellow and white mottles; slightly gritty clay; massive to weak medium angular blocky with moderate discontinuous clayskins; many fine and medium pores; moist and firm (less so than above horizon); common fine black manganiferous concretions; many white soft calcareous patches.
Continued by auger:		
	150-240	Light grey clay; non-calcareous.

Note: Even in a well-drained upper slope site, the lower horizons are somewhat alkaline, with pH (H_2O) of 9.2 and ESP of 14% at 86-125 cm.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-9	9023	1	7	14	9	10	12	47	7.2	6.2	0.08	8.6	0.17	1.68	10	24	3	1.06
9-48	9024	1	6	13	9	9	13	49	8.2	6.9	0.10	8.2	0.13	1.03	8	23	2	1.13
48-86	9025	1	5	13	8	7	14	52	6.6	4.3	0.06	8.5	0.04	0.38	9	3	1	1.07
86-125	9026	2	5	10	6	6	12	59	9.2	7.4	0.36	9.3	0.02	0.18	9	7	1	1.09

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-9	9023	0.1	0.3	5.5	46.9	–	52.8	52.6	100	190	1,050	7,500	9,950	10	500	40	0
9-48	9024	0.3	0.2	5.3	49.4	–	55.2	52.6	100	150	900	7,200	10,500	10	640	40	0
48-86	9025	2.8	0.1	6.2	34.9	–	44.0	51.5	85	60	850	7,400	7,200	<5	220	40	0
86-125	9026	7.3	0.2	9.1	>50.0	–	>66.6	53.9	100	70	1,550	9,200	18,150	10	700	40	2.5

Soil Classification	Suite Yaxa	Subsuite Yalbac
Soil correlation	FAO/UNESCO Vertic Cambisol	USDA Soil Taxonomy Vertic Rendoll

Described: 4.8.89

Location: 6 km north-west of San Felipe (16Q CQ 069 799)

Landform: 1 degree eastward midslope on low rise in flat plain in Shipyard Plain land system

Parent Material: Limestone

Vegetation: Moderately high secondary bush, with moderate density of varied palms

Site Drainage: Imperfect to good

Surface: 2-4 cm of damp fibrous leaf litter

Sample no.	Depth (cm)	
0Z 16/1	0-12	5YR 2.5/2 (dark reddish brown); clay; strong medium angular blocky with many faecal pellets; common fine pores; moist and slightly firm; many fine and common medium roots; gradual regular boundary to:
OZ 16/2	12-31/34	5YR 4/1 (dark grey) with few medium faint grey mottles; clay; weak medium subangular blocky with moderate discontinuous clayskins; common medium and coarse pores; moist-wet and plastic and slightly sticky; common coarse, medium and fine roots; few very fine sub-rounded quartz grit; clear wavy boundary to:
OZ 16/3	31/34-46/74	2.5Y 5/1 (grey) with common coarse faint light grey mottles; clay with patches of slightly gritty clay, especially at top; moderate fine angular blocky-platy with moderate continuous clayskins; common coarse and medium pores; moist-wet, plastic and slightly sticky; common fine roots; common quartz grit and common fine limestone fragments; few fine slightly hard black manganiferous concretions; abrupt very wavy boundary to:
	46/74-150+	10YR 8/2 (white) with many medium faint yellow patches and tongues of brown down old root channels; fine sandy loam – sascab; massive breaking to weak medium angular blocky with moderate continuous pale brown clayskins especially on vertical faces; common medium and fine pores; moist and friable; rare medium and fine live roots but few old coarse root channels; nests of gypsum crystals especially at about 80-100 cm.

Note: Although topographically lower, the lower solum of this profile does not show the degree of alkalinity of the Yaxa profile OZ 15. However, there is visible gypsum in the underlying weathering sascab.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-12	9027	3	3	7	5	5	10	67	7.2	6.6	0.35	9.8	0.48	4.82	10	5	3	1.00
12-31/34	9028	3	3	7	5	5	8	69	7.0	6.0	0.18	9.3	0.26	2.11	8	4	2	1.07
31/34-46/74	9029	8	3	5	4	5	5	70	7.3	6.3	0.74	10.1	0.05	0.41	8	3	1	1.08

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-12	9027	0.4	0.2	10.5	>50.0	–	>61.1	62.2	>98	170	200	6,550	10,900	10	680	50	0
12-31/34	9028	0.6	0.1	7.0	46.7	–	54.4	54.0	100	110	150	6,850	9,200	10	880	60	0
31/34-46/74	9029	1.5	0.1	3.7	>50.0	–	>55.3	53.6	100	50	150	7,200	9,900	10	760	60	0.8

Soil Classification	Suite Yaxa	Subsuite Yalbac
Soil correlation	FAO/UNESCO Eutric Cambisol	USDA Soil Taxonomy Lithic Rendoll
Described:	4.8.89	
Location:	2 km south of Blue Creek Village (16Q CQ 004 775)	
Landform:	1 degree south-west-facing upper slope on low shelf above Blue Creek flats in Shipyard Plain land system	
Parent Material:	Limestone	
Vegetation:	Newly planted Setaria pasture in ploughed land	
Site Drainage:	Good	
Surface:	No litter, scattered limestone fragments up to 5 cm diameter	

Sample no.	Depth (cm)	
0Z 17/1	0-13	5YR 2.5/1 (black); clay; weak medium crumb; common fine pores; moist-wet, plastic and slightly sticky; common medium roots; few fine soft fragments of limestone; many worms; gradual regular boundary to:
OZ 17/2	13-40/68	N3 (very dark grey) with common medium faint dark grey mottles; clay; moderate medium angular blocky with moderate discontinuous clay-skins; few fine pores; moist-wet and sticky and very plastic; few medium roots; few fine soft fragments of limestone; clear very wavy boundary to:
OZ 17/3	40/68-96	Discontinuous horizon in deep pockets of weathering front. 10YR 5/1 (grey) with common medium distinct dark grey mottles; clay; moderate fine angular blocky-lenticular 'flaky' with strong continuous clayskins; common fine pores; moist and slightly firm, plastic and slightly sticky; few fine roots; few fragments of soft limestone; clear very pocketed boundary to:
	40/96-135	2.5Y 8/2 (white) with common fine faint pale yellow patches; clayey sascab; massive crumbling to moderate fine angular blocky with strong continuous clayskins; few fine pores; moist and friable; rare fine roots; gradual regular boundary to:
	135-150+	Slightly hard, fractured angular limestone.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-13	9051	0	1	1	1	3	10	84	8.2	7.2	0.21	15.9	0.33	2.62	8	23	5	1.02
13-40/68	9052	1	0	1	1	3	11	83	8.3	7.2	0.27	16.0	0.14	1.19	8	16	2	1.03
40/68-96	9053	2	0	1	1	4	21	71	8.0	7.4	1.89	10.8	0.08	0.47	6	3	1	1.10

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-13	9051	0.8	0.7	4.6	>50.0	–	>56.1	84.5	>66	290	800	10,950	32,200	20	620	70	3.0
13-40/68	9052	1.1	0.2	3.2	>50.0	–	>54.5	82.4	>66	170	400	11,300	38,600	20	600	70	4.0
40/68-96	9053	2.9	0.1	2.1	>50.0	–	>55.1	56.7	>97	130	400	8,450	154,600	10	350	50	32.0

Soil Classification	Suite Bahia	Subsuite Remate
Soil correlation	FAO/UNESCO Lithic Leptosol	USDA Soil Taxonomy Lithic Eutropept

Described: 6.8.89

Location: 2.5 km north of Progresso (16Q CR 509 182)

Landform: Flat top of rise in flat plain in Xaibe Plain land system

Parent Material: Hard limestone

Vegetation: Low secondary bush with few botans, and gombolimbo, trumpet and cockspur

Site Drainage: Good

Surface: 2-4 cm of fairly dry leaf litter, common fragments of slightly hard limestone

Sample no.	Depth (cm)	
0Z 18/1	0-5/13	5YR 2.5/1 (black); clay; moderate fine subangular blocky breaking to moderate fine crumb; common medium and fine pores; moist and friable; many fine and medium roots; common fragments of slightly hard limestone; common worms; clear slightly wavy boundary to:
	5/13-40+	10YR 8/3 (very pale brown) slightly hard limestone with few fine roots; pockets of 5YR 3/2 (dark reddish brown) stony clay loam; moist and friable; many fine roots; many fragments of softer limestone.

Note: This is one of the Remate profiles developed over solid, rather than fragmented, coral. Note the high potassium status, especially in the total content.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm^3 a.d.s.
0-5/13	9054	4	3	5	4	3	11	70	8.2	7.5	0.94	9.7	0.65	5.83	9	5	4	0.94

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			%
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	$CaCO_3$
0-5/13	9054	0.1	1.9	5.2	>50.0	–	>57.2	54.5	100	260	9,200	6,050	50,600	30	960	40	9.5

Soil Classification	Suite Pembroke	Subsuite Puluacax
Soil correlation	FAO/UNESCO Eutric or Gleyic Cambisol	USDA Soil Taxonomy Eutropeptic Rendoll

Described: 7.8.89

Location: 6.5 km south of Chunox (16Q CR 540 171)

Landform: Top of low rise in flat plain of Xaibe Plain land system

Parent Material: Limestone

Vegetation: Fairly high bush with many botans

Site Drainage: Good

Surface: 1-4 cm of continuous leaf litter

Sample no.	Depth (cm)	
OZ 19/1	1-0	Very dark brown, well humified leaf litter
0Z 19/1	0-13	10YR 4/2 (dark greyish brown) grading to 10YR5/3 (brown); clay; moderate medium prismatic breaking to moderate medium angular blocky, with weak discontinuous clayskins; many fine pores; moist and firm; common fine and medium roots; many fine black specks, probably charcoal; clear regular boundary to:
OZ 19/2	13-31	10YR 5/2 (greyish brown) with many common very fine and very faint reddish brown mottles; clay; massive to weak medium angular blocky with moderate discontinuous clayskins; many fine pores; moist-wet and plastic and slightly sticky; few medium and fine roots; common soft black manganiferous specks; gradual slightly wavy boundary to:
OZ 19/3	31-52	Mixed 10YR 6/6 (brownish yellow) and 10YR 5/2 (greyish brown) with many fine faint reddish yellow mottles; clay; massive to weak – moderate medium angular blocky with weak discontinuous clayskins; few fine pores; moist-wet and slightly plastic and very slightly sticky; few fine roots; common fine black manganiferous species; diffuse boundary to:
	52-90	Mixed white, grey, and brownish yellow; sascab (gritty clay loam texture); moderate fine angular blocky; moist-wet, friable, plastic and slightly sticky; few fine roots; many fine fragments of soft and slightly hard limestone; clear regular boundary to:
	90-100	Almost continuous layer of horizontally aligned fragments of hard carapace limestone:
	100-140+	10YR 8/2 (white) slightly hard angular fractured limestone, with rare fine roots.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-13	9055	2	2	6	9	10	16	55	7.0	5.7	0.23	7.4	0.38	3.42	9	4	2	1.00
13-31	9056	2	1	4	6	6	11	70	7.8	6.2	0.27	8.5	0.17	1.35	8	5	1	1.09
31-52	9057	3	1	3	3	3	9	78	8.5	7.3	0.92	9.9	0.07	0.42	6	4	2	1.08

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-13	9055	2.2	1.7	11.8	22.7	–	38.4	39.3	98	190	8,800	5,550	4,600	20	1020	50	–
13-31	9056	3.8	2.6	13.5	21.6	–	41.5	42.3	98	130	12,750	7,500	4,450	20	1550	60	0.0
31-52	9057	6.5	3.2	15.8	>50.0	–	>75.5	45.8	100	80	13,800	9,100	25,500	20	1320	50	6.0

Soil Classification	Suite Pembroke	Subsuite Xaibe
Soil correlation	FAO/UNESCO Chromic Luvisol	USDA Soil Taxonomy Rhodudalf

Described: 7.8.89

Location: 6 km east of Chunox on Sarteneja Road (16Q CR 625 229)

Landform: Flat area in flat plain in Xaibe Plain land system

Parent Material: Limestone

Vegetation: Moderately high bush with many botans, broom palms, and moderate sapote

Site Drainage: Good

Surface: Fairly smooth with 3-5 cm fairly intact leaf litter

Sample no.	Depth (cm)	
	2-0	Dark reddish brown fibrous root mat with many white hyphae
0Z 20/1	0-6	Mixed 5YR 3/4 and 3/2 (both dark reddish brown); clay; strong medium fine subangular blocky breaking to moderate medium crumb; few medium pores; moist-slightly dry and firm; few coarse and abundant medium and fine roots; common fine soft black spots of charcoal or ferrimanganese; many worms; gradual regular boundary to:
	6-18	5YR 4/6 (yellowish red); clay; moderate fine subangular blocky with weak discontinuous clayskins; many fine and medium pores; moist-dry and firm; many medium and fine roots; few medium soft black manganiferous concretions; diffuse boundary to:
OZ 20/2	18-42	2.5YR 4/6 (red); clay; moderate medium-fine nuciform blocky breaking to moderate medium crumb with moderate discontinuous clay skins; moist-dry and firm; many fine and medium pores; many fine and medium roots; few soft black concretions; diffuse boundary to:
OZ 20/3	42-100	2.YR 5/6 (red); clay; massive-coarse angular blocky breaking to moderate fine crumb with few weak patches of clayskins; common fine pores; moist and firm *in situ* but friable in hand; few medium roots; rare black ferrimanganiferous concretions; abrupt regular boundary to:
	100-125+	White crumbly soft limestone with slightly harder nodules; pockets of soil as above and also widespread red and reddish brown stains; many fine and medium pores; few fine roots.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-6	9058	3	2	2	2	4	15	72	8.1	7.4	0.25	8.3	0.58	5.41	9	8	6	0.88
18-42	9059	1	0	2	1	3	9	84	8.3	7.4	0.13	6.1	0.19	1.04	5	3	2	0.93
42-100	9060	1	0	0	1	2	4	92	8.1	6.7	0.08	6.4	0.10	0.37	4	2	1	0.92

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			%
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	$CaCO_3$
0-6	9058	0.2	2.3	4.2	>50.0	–	>56.7	49.0	100	230	8,900	4,300	23,550	40	1,140	70	3.0
18-42	9059	0.0	1.2	1.6	48.3	–	51.1	27.9	100	130	9,700	3,900	17,500	30	1,550	60	2.5
42-100	9060	0.1	1.6	1.3	24.0	–	27.0	25.9	100	90	10,600	3,800	4,550	20	1,050	70	0.0

Soil Classification	Suite Revenge	Subsuite Tok
Soil correlation	FAO/UNESCO Eutric Planosol	USDA Soil Taxonomy Albaqualf

Described: 10.8.89

Location: Dumb Cane Pine Ridge (16Q CQ 469 901)

Landform: Flat plain in Tok Plain land system

Parent Material: Doubloon Bank limestone with thin siliceous drift

Vegetation: Pine ridge, with pine (*Pinus caribaea*), crabboo, sandpaper tree and calabash

Site Drainage: Good

Surface: Very thin and discontinuous litter of pine needles and grass

Sample no.	Depth (cm)	
OZ 21/1 (0-10)	0-5	10YR 4/1 (dark grey) moist, 10YR 6/1 (light grey) dry; loamy coarse sand; single grain; moist-dry and extremely friable-loose; few medium and fine roots; gradual regular boundary to:
OZ 21/1 (cont)	5-10/36	10YR 7/3 (very pale brown) moist, 10YR 7/1 (light grey) dry; coarse sandy loam; very weak fine subangular blocky breaking to single grain; few fine pores; moist and very friable; few fine roots; rare subrounded quartz stones (up to 3 cm); clear extremely pocketed boundary to:
OZ 21/2	10/36 – 49/59	Mixed 10YR 6/4 (light yellowish brown), 10YR 6/1 (light grey), 7.5YR 5/6 (strong brown) with many medium distinct red mottles; coarse sandy clay loam; moderate medium subangular blocky with weak moderate discontinuous clayskins and discontinuous infillings of 10YR 6/2 (light brownish grey) sandy loam; moist and slightly firm; rare fine roots; gradual wavy boundary to:
OZ 21/3	49/59-96	2.5Y 8/2 (white) with many medium distinct 7.5YR 5/6 (strong brown mottles); sandy clay matrix; moderate coarse angular blocky with wide cracks, strong continuous clayskins overlaid by pronounced infillings of 10YR 5/1 (grey) sandy loam; many fine pores; moist and firm, slightly plastic and slightly sticky; rare fine roots; discontinuous line of patches of slightly hard weathering limestone; common medium-coarse soft black manganiferous concretions especially around limestone; diffuse boundary to:
OZ 21/4	96-146/154	Mixed 2.5YR 8/2 (white) and 5YR 6/8 (yellowish red) with many medium distinct yellow mottles; sandy clay; weak medium angular blocky-massive with moderate discontinuous clayskins; few fine pores; moist and firm; few scattered fine black manganiferous concretions; clear wavy boundary to:
	146/154 – 165+	White soft – hard limestone with some fractures; no roots seen.

Note: The analytical differences between the coarse-grained dystrophic upper horizons and the calcareous subsoil are extremely marked. The topsoil is of Puletan-like poverty except for the slightly higher exchangeable Ca. The total P content of less than 5 ppm is the lowest recorded in Belize in the current series of surveys.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-10	9061	14	26	38	13	6	1	2	6.3	4.9	0.04	0.2	0.02	0.28	14	1	1	1.47
10/36-49/59	9062	9	21	31	9	3	1	26	6.2	4.7	0.04	2.0	0.01	0.09	9	3	0	1.19
49/59-96	9063	4	14	25	8	4	3	42	8.4	7.5	0.13	3.7	0.01	0.03	~ 3	2	1	1.17
96-146/154	9064	4	11	19	5	4	1	56	8.6	7.0	0.10	4.4	0.01	0.01	~ 1	3	1	1.17

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-10	9061	0.0	0.1	0.2	0.7	–	1.0	1.1	91	<5	50	50	<50	<5	70	10	0
10/36-49/59	9062	0.1	0.1	0.9	7.8	–	8.9	9.6	93	40	500	900	1,050	<5	100	20	0
49/59-96	9063	0.1	0.2	1.5	30.1	–	31.9	16.4	100	70	1,100	2,400	11,200	10	160	50	2.5
96-149/154	9064	0.1	0.2	1.4	21.3	–	23.0	21.0	100	100	1,300	2,500	38,500	10	160	60	0

Soil Classification	Suite Altun Ha	Subsuite Jobo
Soil correlation	FAO/UNESCO Skeletal Eutric Cambisol	USDA Soil Taxonomy Skeletal Rendoll

Described: 11.8.89

Location: 2 km north of Honey Camp (16Q CQ 456 967)

Landform: 1 degree slightly convex upper slope on flat plain in Jobo Plain land system

Parent Material: Doubloon Bank Group limestone

Vegetation: Logged high bush with large sapote and small mahogany; many palms including botans and broom palms

Site Drainage: Good

Surface: 2 cm of more or less intact leaf litter over humified fibrous layer with abundant roots and many white hyphae

Sample no.	Depth (cm)	
OZ 22/1 (0-10)	0-4	5YR 2.5/2 (black); fine sandy clay loam; moderate fine crumb; common fine pores; moist and friable; many fine roots; gradual regular boundary to:
OZ 22/1 (0-10)	4-18	7.5YR 3/2 (dark brown) merging to 7.5YR 4/2 (brown); fine sandy clay loam; moderate medium subangular blocky with weak patchy clayskins; common fine and medium pores; moist and slightly firm, slightly plastic; common medium palm roots; gradual; regular boundary to:
	18-34	10YR 6/2 (light grey) with many fine faint brown mottles; very stony coarse sandy clay; stone- dominated structure with interstitial patches of weak fine subangular blocky, with moderate discontinuous clayskins against stones; many fine pores; moist and stony, with interstitial fine earth plastic and slightly sticky; common medium palm roots; abundant horizontally aligned flat hard reddish-brown stained subrounded quartz stones up to 6 cm; clear slightly wavy boundary to:
OZ 22/2	34-50	10YR 7/2 (light grey) with many medium distinct brown and reddish brown mottles; gritty clay; moderate medium-fine angular blocky with moderate discontinuous clayskins; many fine pores; moist and firm; few medium roots; grit is angular quartz; rare subrounded quartz stones up to 3 cm; common slightly hard manganiferous concretions; gradual regular boundary to:
OZ 22/3	50-68	2.5Y 7/2 (light grey) with many medium faint pale yellow and very pale brown mottles; clay; strong medium angular blocky with moderate continuous clayskins; few fine pores; moist and firm; few medium and fine roots; rare subrounded quartz stones; clear slightly wavy boundary to:
OZ 22/4	68-92/103	2.5YR 8/4 (pale yellow) with common medium faint pale brown mottles; silty clay; weak fine angular blocky with moderate discontinuous clayskins; few coarse pores; moist-dry and slightly friable; rare fine roots; common subrounded flints concentrated in upper 10 cm; calcareous; clear wavy boundary to:
	92/103 – 120+	Soft white limestone; slightly fractured with pale brown stains down cracks; rare fine roots in cracks.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-10	9065	4	20	23	7	5	9	32	6.5	5.6	0.12	5.1	0.31	3.30	11	2	3	1.09
34-50	9066	11	13	13	5	4	6	48	6.4	4.9	0.12	7.4	0.03	0.21	7	2	1	1.20
50-68	9067	5	10	11	4	5	8	57	8.3	7.1	0.14	9.1	0.02	0.13	6	2	1	1.14
68-92/103	9068	1	3	6	21	14	23	32	8.7	7.6	0.12	4.2	0.02	0.17	8	1	1	1.21

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-10	9065	0.2	0.5	3.7	27.5	–	31.9	33.2	96	80	1,150	2,500	5,400	10	390	20	0
34-50	9066	0.3	0.3	3.4	26.4	–	30.4	32.5	94	40	1,850	4,050	5,200	10	840	30	0
50-68	9067	0.2	0.4	3.6	>50.0	–	>54.2	40.4	100	40	2,300	5,900	29,300	10	850	40	0
68-92/103	9068	0.1	0.3	1.8	>50.0	–	>52.2	20.3	100	40	1,750	4,650	252,450	10	330	20	60.0

Soil Classification	Suite Guinea Grass	Subsuite Pixoy
Soil correlation	FAO/UNESCO Eutric Planosol	USDA Soil Taxonomy Rendollic Rhodudalf

Described:	11.8.89
Location:	1.5 km east of Chiwa Lagoon (16Q CQ 514 975)
Landform:	Flat crest in flat plain subunit in Jobo Plain land system
Parent Material:	Siliceous wash over limestone
Vegetation:	Logged high bush with mahogany, gombolimbo, and many broom palms
Site Drainage:	Good
Surface:	3 cm of fibrous and well rooted leaf litter

Sample no.	Depth (cm)	
OZ 23/1	0-8	10YR 4/1 (dark grey) with many bleached coarse quartz sand grains; loamy medium sand; very weak medium crumb breaking to single grain; moist and extremely friable; abundant medium and fine roots; clear regular boundary to:
OZ 23/2	8-26	7.5YR 5/6 (strong brown) with many medium faint 5YR 5/6 (yellowish red) mottles; medium sandy loam-loamy sand, very weak fine subangular blocky breaking to single grain; few medium pores; moist and very friable; common medium and fine roots; clear regular boundary to:
OZ 23/3	26-42	5YR 5/6 (yellowish red) with many medium distinct 2.5YR 5/6 (red) mottles; medium sandy clay; moderate medium angular blocky with weak discontinuous clayskins; common medium and fine pores; moist and slightly friable; few coarse and common medium roots; common medium round hard black manganiferous concretions; clear regular boundary to:
	42-48/53	10YR 5/8 (yellowish brown) with common medium distinct red and yellowish red mottles; clay-sandy clay; moderate fine angular blocky: few coarse pores; moist and slightly firm; few fine roots; many fine hard black manganiferous concretions; clear slightly wavy boundary to:
	48/53 – 65+	White limestone with creamy – pale brown staining in upper 5 cm; massive and unfractured; slightly hard – hard.

Note: The textures are coarser and the colours redder than the Puluacax brown clay originally mapped. However, the other soils seen in this area were similar. The thin yellowish horizon at the base of the solum is somewhat similar to the lower olive subsoils over limestone in Toledo District. The decrease in clay content from topsoil to the second horizon is unusual and causes the very low cation exchange capacity.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-8	9069	2	11	39	23	10	4	11	7.2	6.6	0.15	2.0	0.30	3.39	11	1	3	1.05
8-26	9070	4	12	40	28	9	3	4	7.3	6.1	0.04	0.3	0.02	0.15	8	1	1	1.40
26-42	9071	3	6	15	10	4	2	60	7.1	5.7	0.06	4.1	0.09	0.51	6	2	1	1.07

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-8	9069	0.1	0.3	1.9	18.4	–	20.7	17.8	100	70	850	600	5,500	10	310	20	0.0
8-26	9070	0.0	0.1	0.2	1.6	–	1.9	1.6	100	20	400	200	200	10	290	10	
26-42	9071	0.1	0.5	1.0	14.1	–	15.7	16.6	95	60	4,200	2,200	2,500	10	150	50	

Soil Classification	Suite Pembroke	Subsuite Xaibe
Soil correlation	FAO/UNESCO Chromic Luvisol	USDA Soil Taxonomy Rhodudalf

Described:	14.8.89
Location:	Little Belize, 7.5 km west of Progresso Lagoon (16Q CR 590 138)
Landform:	Low flat crest in flat plain in Xaibe Plain land system
Parent Material:	Limestone
Vegetation:	Moderately high broadleaf bush, with gombolimbo, sapote, white chechem, and also many botan palms
Site Drainage:	Good
Surface:	3-4 cm mixed wood and leaf litter

Sample no.	Depth (cm)	
0Z 24/1	0-9	2.5YR 3/4 (dark reddish brown); clay; moderate fine subangular blocky with weak discontinuous pressure faces; common fine pores; moist and slightly friable; many fine and medium roots; few fine black manganiferous concretions; gradual regular boundary to:
OZ 24/2	9-34	2.5YR 4/4 (reddish brown); clay; moderate medium subangular blocky with moderate discontinuous clayskins; variable density of pores with nests of common medium; slightly moist and compact; common medium and fine roots; few black manganiferous concretions; gradual regular boundary to:
OZ 24/3	34-65	2.5YR 4/8 (red); clay; weak moderate angular blocky breaking to moderate medium crumb with weak discontinuous clayskins; many fine pores; moist and slightly firm; few medium and fine roots; common black hard and slightly hard manganiferous concretions; abrupt rectilinearly pocketed boundary to:
	65-80	Discontinuous horizon in deeper pockets in limestone. 2.5YR 4/4 (reddish brown); clay; moderate fine subangular blocky; many fine pores; moist and friable; concentration of roots of all sizes; few fragments of limestone; few black manganiferous concretions; abrupt pocketed boundary to:
	65-80+	Hard white horizontally bedded limestone, with few fine roots in cracks.

		Particle size class							pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
		Sand				Silt		Clay										
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-9	9072	0	1	1	4	5	10	79	6.9	6.7	0.22	6.9	0.60	5.63	9	2	–	0.86
9-34	9073	0	1	1	3	4	6	85	5.7	6.8	0.09	5.7	0.36	2.35	7	2	–	0.96
34-65	9074	3	0	0	1	2	2	92	6.2	6.9	0.36	6.2	0.17	0.78	5	3	–	0.97

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			%
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	$CaCO_3$
0-9	9072	0.2	1.8	5.1	27.9	–	35.0	36.1	97	190	8,550	3,500	6,400	20	590	70	–
9-34	9073	0.2	1.6	3.4	19.0	–	24.2	26.6	91	130	9,000	3,400	3,750	20	570	60	–
34-65	9074	1.6	1.0	2.8	19.1	–	24.5	25.0	98	90	9,350	3,800	3,500	10	290	60	–

Soil Classification	Suite Altun Ha	Subsuite Jobo
Soil correlation	FAO/UNESCO Orthic Luvisol	USDA Soil Taxonomy Hapludalf
Described:	17.8.89	
Location:	1 km south-east of Biscayne (16Q CQ 463 587)	
Landform:	Flat crest of low rise in flat plain in Jobo Plain land system	
Parent Material:	Doubloon Bank Group limestone	
Vegetation:	High cohune ridge, with high density of mature cohunes	
Site Drainage:	Slightly imperfect	
Surface:	3-4 cm cohune litter	

Sample no.	Depth (cm)	
OZ 25/1	0-10	10YR 3/1 (very dark grey); medium sandy clay loam; moderate medium subangular blocky; many fine pores; moist and firm; common medium and fine cohune roots; no worms; gradual regular boundary to:
	14-29/32	N5 (grey) with common fine faint brown and yellowish brown mottles; medium sandy clay; moderate fine angular blocky with weak discontinuous clayskins mainly lining root channels; many fine pores; moist and firm; common medium cohune roots; clear regular boundary to:
	29-32	Discontinuous stone line of mainly angular flints in soil as above
OZ 25/2	32-62	10YR 4/1 (dark grey) with many fine faint reddish brown mottles; medium sandy clay; massive-weak medium angular blocky; common fine pores; moist and firm; few medium roots; few rounded quartz stones; gradual regular boundary to:
	62-80	10YR 4/1 (dark grey) with many medium faint olive yellow mottles; medium sandy clay; weak medium angular blocky; few fine pores; moist and firm; few medium roots; gradual regular boundary to:
	80-103	10YR 4/2 (dark greyish brown) with few medium faint yellow mottles; medium sandy clay; moderate fine angular blocky with moderate discontinuous clayskins; many fine pores; moist and firm; few medium roots; few soft white calcareous patches; gradual regular boundary to:
OZ 25/3	103-140+	10YR 7/2 (light grey) with many medium distinct yellow and reddish yellow mottles; medium sandy clay; strong fine angular blocky with moderate discontinuous clayskins; many fine pores; moist and firm, slightly sticky; rare fine roots; common soft white calcareous patches.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-14	8994	5	18	24	9	8	10	26	6.3	5.6	0.11	3.7	0.21	2.03	10	9	4	1.06
32-62	8995	7	15	19	9	7	7	36	6.9	5.6	0.06	4.5	0.03	0.29	10	8	2	1.17
103-140	8996	7	12	14	7	6	8	46	8.2	7.5	0.71	6.3	0.02	0.11	~6	3	2	1.11

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-14	8994	0.1	0.1	2.4	22.1	–	24.7	24.5	100	260	500	1,650	4,400	10	80	30	–
32-62	8995	0.3	0.1	1.1	23.1	–	24.6	24.5	100	70	600	2,050	4,150	10	90	30	0.0
103-140	8996	1.4	0.3	1.6	44.6	–	47.9	29.2	100	50	1,200	3,100	20,000	10	70	40	3.5

Soil Classification	Suite Richardson	Subsuite Doyle
Soil correlation	FAO/UNESCO Humic Ferralsol	USDA Soil Taxonomy Sombriudox

Described:	21.8.89
Location:	Close to highest point of main divide of Maya Mountains (16Q BP 817 247)
Landform:	Convex upper slope of knoll on narrow ridge. Gradient ca 15 degrees
Parent Material:	Bladen Volcanics andesite
Vegetation:	Lightning-disturbed Lower Montane Forest, with many palms including *Coplothrinax cooki*. Largest broadleaf trees are *Clusia* spp.
Site Drainage:	Good
Surface:	6 cm of reddish brown very fibrous moist leaf litter

Sample no.	Depth (cm)	
	6-0	5YR 2.5/2 (dark reddish brown) fibrous humic litter, silty feel; moist and soft; abundant roots of all sizes; clear regular boundary to:
OZ 26/1	0-11	5YR 2.5/1 (black); humic (silty) loam; weak fine crumb; common fine pores; moist and soft; many medium and coarse roots; clear regular boundary to:
OZ 26/2	11-15	5YR 5/2 (reddish grey) with common medium very faint 7.5YR 5/4 (brown) mottles; silty clay; weak medium subangular blocky; many fine pores; moist and slightly firm; common medium and fine roots; clear slightly wavy boundary to:
OZ 26/3	15-20	5YR 3/3 (dark reddish brown) with some peds having 7.5YR 5/6 (strong brown) interiors; medium sandy clay loam; moderate medium subangular blocky breaking to strong fine crumb; many fine pores; moist and firm-crisp, almost fragic; many medium and fine roots; common black spots, probably old root remains; gradual regular boundary to:
	20-24/29	5YR 4/4 (reddish brown) with common medium faint 5YR 3/3 (dark reddish brown) and 7.5YR 5/6 (strong brown) mottles; medium sandy loam; moderate medium subangular blocky breaking to strong fine crumb; many fine pores; moist and firm-crisp, almost fragic; common medium roots; gradual slightly wavy boundary to:
OZ 26/4	24/29-62	7.5YR 5/6 (strong brown) with common medium faint dark brown mottles; medium sandy clay; moderate medium angular blocky with weak discontinuous clayskins; many fine pores; moist and firm-crisp, almost fragic; common medium palm roots; diffuse boundary to:
OZ 26/5	62-160	10YR 6/8 (brownish yellow) with many fine faint yellow and reddish yellow mottles; medium sandy clay with patches of stony clay; moderate medium subangular blocky with weak discontinuous clayskins; common fine pores; moist and friable, but also slightly crisp; common palm roots decreasing to few; common patches of reddish and yellowish weathering metaandesite, increasing to many with depth; diffuse boundary to:
	160-170+	Slightly hard – soft red, yellow and purple weathering andesite, with interstitial patches of soil as above.

Note: The upper horizons of this profile appear to be the result of weak podzolization, with 0-11 as an A1, 11-15 as an A2, 15-20 as a weak Bh, and 20-24/29 as an even weaker Bs. The remainder of the profile appears to have formed largely by *in situ* weathering, possibly also with some argilluviation.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-11	8997	0	2	6	9	17	39	27	3.6	2.9	0.31	11.3	1.98	68*	~34	2	–	0.31
11-15	8998	0	3	5	8	11	35	38	3.7	2.7	0.82	4.0	0.29	3.81	13	2	–	0.82
15-20	8999	0	2	4	8	11	36	39	3.8	3.1	0.77	6.4	0.34	5.28	16	2	–	0.77
24/29-62	9000	1	2	5	8	10	38	36	4.4	3.9	0.85	4.3	0.13	2.16	17	1	–	0.85
62-160	9001	5	5	13	10	10	36	20	4.8	4.5	1.01	1.5	0.03	0.54	18	3	–	1.01

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-11	8997	0.4	0.6	4.5	4.8	8.5	10.3	84.0	12	550	4,500	1,450	1,300	10	40	20	–
11-15	8998	0.1	0.1	0.5	0.2	16.4	0.9	29.4	3	390	16,800	3,100	<25	10	30	30	–
15-20	8999	0.1	0.2	0.2	0.2	21.7	0.6	40.5	1	420	16,300	3,100	<25	<5	30	30	–
24/29-62	9000	0.0	0.0	0.0	0.2	8.1	0.2	17.2	1	440	17,100	3,050	<25	10	30	30	–
62-160	9001	0.0	0.0	0.0	0.1	1.5	0.1	3.2	3	280	27,400	3,550	<25	10	30	40	–

* = Loss on ignition, not organic C

Soil Classification	Suite Richardson	Subsuite Palmasito
Soil correlation	FAO/UNESCO Haplic Ferralsol	USDA Soil Taxonomy Hapludox
Described:	22.8.89	
Location:	Helipad on main divide ridge of Maya Mountains (16Q BP 828 251)	
Landform:	Convex upper slope of spur main ridge in Richardson Peak Mountains land system. Gradient 3 degrees	
Parent Material:	Bladen Volcanics metaandesite	
Vegetation:	Cleared high forest with a high proportion of palms, including *Coplothrinax cooki*	
Site Drainage:	Good	
Surface:	4-6 cm of fibrous leaf litter	

Sample no.	Depth (cm)	
	4-0	Very dark brown fibrous leaf litter
OZ 27/1	0-4	5YR 3/2 (dark reddish brown) with common fine faint brown mottles; humic silty loam; moderate fine crumb; common fine pores; moist and friable; abundant fine and medium roots; no worms seen; clear regular boundary to:
OZ 27/1	4-10	7.5YR 3/2 (dark brown) with common medium distinct strong brown and reddish yellow mottles; silty clay-silty clay loam; moderate medium subangular blocky breaking to strong coarse crumb with weak discontinuous clayskins; many fine pores; moist and slightly friable; many medium and fine roots; clear regular boundary to:
OZ 27/2	10-30	7.5YR 6/6 (reddish yellow); fine sandy clay loam-fine sandy clay; weak medium subangular or blocky breaking to moderate medium crumb with weak discontinuous clayskins; abundant fine pores; moist and friable; common medium palm and fine roots; diffuse boundary to:
OZ 27/3	30-90	7.5YR 7/8 (reddish yellow); medium sandy clay loam; weak fine angular blocky breaking to moderate fine crumb with weak discontinuous clayskins; common fine and medium pores; moist and slightly firm and slightly crisp; common medium palm roots; rare fragments of soft reddish and yellowish weathering andesite; diffuse boundary to:
OZ 27/4	90-145+	7.5YR 7/6 (reddish yellow) with abundant fine distinct yellowish red, yellow, and pale yellow mottles; medium sandy clay loam; weak medium angular blocky breaking to moderate fine angular blocky with medium discontinuous clayskins; many fine and medium pores; moist and friable and slightly crisp; few medium palm roots; common patches of red, yellow and orange weathering andesite increasing to many at depth.

Note: There are no apparent signs of the incipient podzolization seen in profile OZ 26. This soil is extremely acid and base-deficient, presumably due to the high rainfall and leaching. The total Ca levels in soils from this parent material are very low.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm^3 a.d.s.
0-10	9002	2	1	6	8	10	35	38	3.8	3.3	0.16	3.4	0.30	4.07	14	3	–	0.83
10-30	9003	2	1	5	8	9	33	42	4.1	3.8	0.10	3.9	0.20	2.73	14	1	–	0.80
30-90	9004	6	3	8	6	9	34	34	4.9	4.5	0.04	2.2	0.04	0.60	15	1	–	0.98
90-145	9005	1	1	10	8	9	40	31	5.1	4.4	0.03	1.2	0.01	0.22	~22	1	–	0.94

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity		Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	Base sat. %	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-10	9002	0.1	0.1	0.3	0.3	11.2	0.8	17.3	5	430	3,150	1,300	100	20	50	30	–
10-30	9003	0.0	0.1	0.1	0.2	9.1	0.4	16.2	2	390	3,500	1,300	<25	10	20	30	–
30-90	9004	0.0	0.0	0.0	0.1	2.0	0.1	5.1	2	490	4,850	1,250	50	10	20	50	–
90-145	9005	0.0	0.0	0.0	0.3	2.3	0.3	4.3	7	450	8,300	1,650	<25	10	10	40	–

Soil Classification	Suite Richardson	Subsuite Palmasito
Soil correlation	FAO/UNESCO Haplic Ferralsol	USDA Soil Taxonomy Hapludox

Described: 23.8.89

Location: 100 m downhill from helipad camp, on main divide of Maya Mountains (16Q BP 827 248)

Landform: 34 degrees rectilinear midslope of headwater valley of Snake Creek system in Richardson Peak Mountains land system

Parent Material: Meta andesite of Bladen Volcanics

Vegetation: High primary forest, including many palms especially *Colpothrinax cooki*

Site Drainage: Very free

Surface: Slight irregular treefall microrelief. 4-6 cm well-rooted fibrous leaf litter

Sample no.	Depth (cm)	
	9-5	More or less intact leaf litter, with many fine fibrous blunt-ended roots and common patches of white hyphae
	5-0	5YR 2.5/2 (dark reddish brown); humic litter (silty loam texture) with abundant fine and medium roots as above; common patches of white hyphae
OZ 28/1	0-4	5YR 4/3 (reddish brown); slightly gritty fine sandy clay loam; weak medium subangular blocky breaking to moderate fine crumb; common fine pores; moist and friable; many fine and medium roots; few fine slightly hard grit; gradual regular boundary to:
OZ 28/1 (cont)	4-14	5YR 4/4 (brown); slightly gritty fine sandy clay loam; very weak medium subangular blocky breaking to moderate fine crumb; common fine pores; moist and very friable; many fine and medium roots; few fine slightly hard grit; gradual regular boundary to:
OZ 28/2	14-56	5YR 4/6 (yellowish red); very slightly gritty clay loam; moderate medium-coarse subangular blocky breaking to moderate fine crumb; abundant coarse to fine pores; moist and extremely friable and slightly crisp; common fine and medium palm roots; rare grit: diffuse boundary to:
OZ 28/3	56-116	5YR 5/8 (yellowish red); clay loam; weak coarse angular blocky breaking to moderate subangular blocky with very weak and very discontinuous clayskins; many coarse to fine pores; moist and friable; common decreasing to few medium palm roots; rare fine andesite grit; diffuse boundary to:
	116-140	5YR 7/8 (reddish yellow) with many fine distinct yellow, red and yellowish red mottles; gritty stony clay loam; weak coarse angular blocky breaking to weak fine angular blocky; abundant fine and medium pores; moisty and friable; few medium palm roots; common patches of soft to slightly hard red to pale yellow weathering andesite; clear slightly wavy boundary to:
	140-160+	Mixed red, yellow brown and pale yellow soft-hard weathering andesite; massive with pockets of softer material; rare palm roots.

		Particle size class: Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm^3 a.d.s.
0-10	9006	1	2	5	7	13	36	36	3.8	3.3	0.15	4.3	0.35	4.97	14	2	–	0.77
14-56	9007	1	1	3	7	12	36	40	4.3	4.0	0.17	4.7	0.23	3.33	14	2	–	0.80
56-116	9008	2	2	6	6	13	33	38	4.9	4.3	0.05	3.3	0.07	0.85	12	2	–	0.89

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-10	9006	0.1	0.1	0.4	0.2	13.9	0.8	23.7	3	320	8,400	2,150	<25	10	30	40	–
14-56	9007	0.0	0.0	0.1	0.2	7.3	0.3	17.0	2	310	7,400	1,950	<25	10	30	40	–
56-116	9008	0.1	0.0	0.1	0.5	2.2	0.7	6.6	11	250	7,600	1,950	100	10	30	40	–

Soil Classification	Suite Richardson	Subsuite Palmasito
Soil correlation	FAO/UNESCO Haplic Ferralsol	USDA Soil Taxonomy Hapludox

Described: 23.8.89

Location: 1 km south-east of helipad camp, Main Divide (16Q BP 833 244)

Landform: Lower end of nose of spur running out from Main Divide in Richardson Peak Mountains land system. Gradient down nose 17 degrees.

Parent Material: Bladen Volcanics metarhyolite, possibly with some andesitic colluvium

Vegetation: High primary forest. Proportions of palms higher and of santa maria lower than further upslope

Site Drainage: Good

Surface: 6-16 cm depth of mixed fibrous and humic leaf litter

Sample no.	Depth (cm)	
	6-0	Dark brown fibrous and humic litter. Upper surface smooth but pockets up to 16 cm deep in old treefall pits
OZ 29/1	0-4	7.5YR 5/2 (brown) with common medium faint grey and yellowish brown mottles; silty clay; strong coarse angular blocks which persist as single units through to the next horizon; many medium old palm root pores; moist and firm; many medium palm roots; gradual regular boundary to:
OZ 29/1 (cont)	4-10	7.5YR 6/8 (reddish yellow) with common medium distinct light grey and greyish brown mottles; silty clay; strong coarse angular blocky which are continuations from above horizon; many medium old palm root pores; moist and firm; common palm roots; gradual regular boundary to:
OZ 29/2	10-32	7.5YR 6/8 (reddish yellow) with common medium faint yellow mottles; silty clay; moderate coarse angular blocky with dark coatings down some cracks; common medium pores; moist and slightly firm; common palm roots; diffuse boundary to:
OZ 29/3	32-62	5YR 6/8 (reddish yellow) with many medium faint yellow mottles; silty clay-clay; weak coarse angular blocky breaking to moderate fine angular blocky with weak discontinuous clayskins and some dark brown coatings; common medium pores; moist and slightly firm; few medium palm roots; rare subangular fragments of slightly hard white rhyolite; diffuse boundary to:
OZ 29/4	62-124	7.5YR (reddish yellow) with common coarse patches of 10YR 6/8 (brownish yellow); silty clay-clay; weak coarse angular blocky breaking to moderate fine angular blocky with weak discontinuous clayskins; common medium pores; moist and firm; many medium palm and rare coarse roots; few concentrated patches of hard white rhyolite stones; diffuse boundary to:
	124-140+	Slightly hard white and yellow weathering rhyolite.

Note: The rhyolite gives rise to high contents of fine silt. This soil is acid and low in exchangeable cations.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-10	9009	1	1	1	2	12	60	23	4.3	3.4	0.06	1.6	0.14	1.33	10	1	–	1.00
10-32	9010	1	1	1	2	12	59	24	4.4	3.6	0.05	1.6	0.11	0.76	7	1	–	1.01
32-62	9011	1	0	1	2	14	53	29	4.6	3.9	0.04	1.6	0.08	0.56	7	1	–	1.06
62-124	9012	1	0	1	2	23	48	24	4.8	4.2	0.03	1.0	0.05	0.25	5	1	–	1.13

		Exchangeable cations me/100 g a.d.s.						Cation exchange capacity		Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	TEB me % o.d.s.	me/100 g	Base sat. %	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-10	9009	0.2	0.2	0.4	0.4	5.5	0.9	8.8	10	160	11,600	1,350	50	20	20	20	–
10-32	9010	0.0	0.0	0.1	0.2	6.3	0.3	8.0	4	160	11,150	1,300	<25	20	30	30	–
32-62	9011	0.0	0.0	0.1	0.2	4.4	0.3	7.6	4	180	10,450	1,350	<25	30	30	40	–
62-124	9012	0.0	0.0	0.0	0.3	2.0	0.3	3.4	9	160	8,550	1,100	<25	20	30	20	–

Soil Classification	Suite Tintal	Subsuite Ycacos
Soil correlation	FAO/UNESCO Eutric Gleysol	USDA Soil Taxonomy Salic Hydraquent

Described: 26.8.89

Location: Eastern shore of Santa Cruz Lagoon, northern Ambergris Cay (16Q DR 040 000)

Landform: Mangrove swamp in Corozal Saline Swamps land system

Parent Material: Recent mud over Pleistocene coral limestone

Vegetation: Black mangrove up to 5 m high, with few silver buttonwood

Site Drainage: Poor

Surface: Bare except for many pneumatophores

Sample no.	Depth (cm)	
	0-3	Mixed 10YR 6/3 (pale brown) and 2.5Y 5/2 (greyish brown) with many medium faint yellow mottles; silty loam; weak medium subangular blocky; few fine pores; moist-wet and friable-soft; common medium roots; clear regular boundary to:
OZ 30/1	3/15	5Y 6/1 (grey-light grey); slightly gritty clay; weak medium angular blocky with moisture films; few medium pores; moist – wet and plastic and slightly sticky; few fine roots; few gritty gypsum crystals; clear slightly wavy boundary to:
	15-26	5YR 8/1 (white) with common medium faint very pale brown mottles; gritty silty clay; weak fine angular blocky; few medium pores; moist-wet and plastic and slightly sticky; few fine roots; common gritty gypsum crystals; clear regular boundary to:
	26-30	Indurated layer of N6/. (grey-light grey) with many medium faint pale yellow and pale brown mottles; very gritty clay; strong medium angular blocky with weak discontinuous coatings or pressure faces; many medium pores; moist-wet and indurated; no roots; grit is abundant medium gypsum crystals up to 1 cm diameter; clear regular boundary to:
OZ 30/2	30-40	N5/. (grey); silty clay; massive; wet, sticky and plastic; no roots; abrupt slightly wavy boundary to:
	40+	Hard coral limestone

Note: Most of the high content of fine silt in the subsoil is comminuted coral.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Soluble cations me/100 g Na	Soluble cations K	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
3-15	9013	0	1	0	0	3	5	91	8.3	8.3	15.85	63.7	0.3	10.2	0.05	0.49	10	5	2	0.98
30-40	9014	2	1	1	0	5	59	32	8.6	9.2	11.59	47.7	0.6	2.0	0.09	1.11	12	0	3	0.81

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
3-15	9013	20.0	3.8	36.3	44.8	–	104.9	24.6	100	130	9,850	14,100	24,600	10	140	40	5.0
30-40	9014	8.7	0.6	23.1	>50.0	–	>82.4	5.6	100	60	1,400	26,400	314,700	10	490	10	80.0

Soil Classification	Suite Turneffe	Subsuite Shipstern
Soil correlation	FAO/UNESCO Eutric Cambisol	USDA Soil Taxonomy Eutropept

Described: 26.8.89

Location: Eastern end of Basil Jones airstrip, Ambergris Cay (16Q DR 057 001)

Landform: Low former beach on coral platform in North Ambergris Plain land system

Parent Material: Holocene mud over Pleistocene coral limestone

Vegetation: Low scrubby forest with many palms, including chit, and some black and white chechem

Site Drainage: Good

Surface: 3 cm of dry leaf litter

Sample no.	Depth (cm)	
OZ 31/1	0-9	7.5YR 3/2 (dark brown); silty loam; moderate fine subangular blocky breaking to moderate fine crumb; many fine pores; moist-dry and friable; many fine-coarse roots; clear regular boundary to:
OZ 31/2	9-49	5YR 3/2 (dark reddish brown); clay loam; massive-weak fine-medium angular blocky with weak discontinuous clayskins; many fine pores; moist and indurated *in situ* becoming friable when unconfined (fragic), soft in the bottom few cm; rare fine roots; few common manganiferous concretions in lower few cm; abrupt slightly wavy boundary to:
	49+	Hard carapace of coral limestone.

Note: This soil has lost its marine characteristics, now having low conductivity and low ESP. It is fairly well leached with near neutral pH's and less than total base saturation. It appears to be well endowed with nutrients, having high N and P contents.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-9	9015	2	1	2	1	7	35	52	6.9	5.8	0.13	10.0	0.85	8.09	10	23	5	0.81
9-49	9016	3	2	2	2	5	26	60	6.7	5.3	0.09	8.3	0.30	2.45	8	5	2	1.01

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-9	9015	0.6	0.9	4.4	38.6	–	44.5	49.3	90	1,750	6,250	6,450	9,400	30	220	50	–
9-49	9016	1.0	0.2	3.4	20.7	–	25.3	31.8	80	980	6,800	7,000	5,200	20	740	60	–

Soil Classification		Suite Tintal	Subsuite Ycacos
Soil correlation		FAO/UNESCO Lithic Gleysol	USDA Soil Taxonomy Lithic Hydraquent
Described:		28.8.89	
Location:		North-western corner of Laguna de San Pedro, southern Ambergris Cay (16Q CQ 987 862)	
Landform:		Slight depression in low coral platform just above level of lagoon in North Ambergris Plain land system	
Parent Material:		Recent mud over Pleistocene coral limestone	
Vegetation:		Scrubby broadleaf bush with many black chechem	
Site Drainage:		Intermittently impeded	
Surface:		Bare	
Sample no.	Depth (cm)		
	0-7	10YR 2.5/1 (black); silty clay loam; weak fine crumb; many fine pores; moist and extremely friable; common fine and medium roots; clear regular boundary to:	
OZ 32/1	7-32/45	7.5YR 3/2 (dark brown); clay loam; weak medium subangular blocky breaking to moderate fine crumb; moist and friable; common fine and medium roots; few fine hard black manganiferous concretions at base of horizon; abrupt wavy boundary to:	
	32/45+	Hard white carapace of coral limestone.	

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Soluble cations me/100 g Na	Soluble cations K	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
7-32/45	9017	4	2	4	2	3	24	61	7.5	6.9	3.69	12.7	0.0	8.6	0.43	4.32	10	5	2	0.90

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
7-32/45	9017	11.0	2.3	19.7	24.7	–	57.7	44.4	100	320	8,300	11,250	6,750	10	830	60	–

Soil Classification	Suite Yaxa	Subsuite Yalbac
Soil correlation	FAO/UNESCO Vertic Cambisol	USDA Soil Taxonomy Vertic Rendoll

Described: 31.8.89

Location: 2 km north-west of Gallon Jug (16Q BQ 806 438)

Landform: 1 degree upper slope in gently undulating plain in Gallon Jug Plain with Hills land system

Parent Material: Cretaceous limestone

Vegetation: Area of uncleared high bush in zone of tree crop development. Many sapote and black chechem

Site Drainage: Imperfect to good

Surface: 2-4 cm of fairly dry leaf litter, with very gentle old treefall microtopography

Sample no.	Depth (cm)	
	3-0	Dark brown fibrous leaf litter with many patches of white hyphae
OZ 33/1	0-2/4	10YR 2.5/2 (black); humic silty clay loam; moderate fine subangular blocky; few medium pores; moist and slightly firm; abundant fine and medium roots; few worms; clear slightly wavy boundary to:
OZ 33/1 (cont.)	2/4-18	10YR 5/2 (greyish brown); silty clay; moderate fine angular-subangular blocky with moderate discontinuous pressure faces; few fine and medium pores; moist and firm; common fine and medium roots; few fragments of subrounded slightly hard limestone; diffuse boundary to:
OZ 33/2	18-42	10YR 4/1 (dark grey); clay; moderate medium angular blocky breaking to moderate fine angular blocky with continuous pressure faces; common fine and few medium pores; moist and slightly firm, plastic and slightly sticky; common medium and fine roots; rare fragments of slightly hard subrounded limestone; gradual regular boundary to:
	42-53	10YR 5/1 (grey) with common medium fine pale brown mottles; clay; massive-weak medium angular blocky with some rounded nuciform structures, with moderate discontinuous pressure faces; common medium and coarse pores; moist and slightly firm, sticky and plastic; few fine roots; common fine slightly hard white limestone gravel; clear regular boundary to:
	53-60	Discontinuous stone line of subrounded slightly hard soapy-feeling limestone set in interstitial soil as above;
	60-90+	10YR 8/3 (very pale brown) with many medium distinct reddish yellow and grey mottles; clay sascab; massive-weak medium subangular blocky with moderate pressure faces; many fine pores; moist and slightly friable; common fine roots; common rounded inclusions of much harder white and creamy limestone.

Note. The high exchangeable and total Mg contents indicate that the parent material is dolomitic. The high total Mn contents do not result in ferrimanganiferous concretions or stains.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-15	8965	1	0	2	2	5	12	78	7.2	5.9	0.47	12.1	0.33	1.95	6	3	0	1.11
18-42	8966	1	0	1	2	1	9	86	7.2	5.5	0.07	13.5	0.14	0.89	6	3	0	1.09

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-15	8965	0.8	0.3	13.5	39.7	–	54.3	53.7	100	110	800	6,600	8,000	30	1,860	80	–
18-42	8966	0.3	0.2	16.5	39.7	–	56.7	57.0	99	80	750	7,850	8,000	30	1,760	80	–

Soil Classification	Suite Yaxa	Subsuite Yalbac
Soil correlation	FAO/UNESCO Pelli-eutric vertisol	USDA Soil Taxonomy Pelludert

Described: 31.8.89

Location: 4 km east of Gallon Jug on Hillbank road (16Q BQ 868 424)

Landform: Close to dissecting drainage in low part of undulating plain in Gallon Jug Plain with Hills land system; flat

Parent Material: Cretaceous limestone

Vegetation: Underbrushed and windrowed high cohune ridge, with many cohunes, and some quamwood, sapote, mahogany and botan. About to be planted with cacao

Site Drainage: Imperfect

Surface: Discontinuous leaf litter of 1-2 cm in areas that have been windrowed

Sample no.	Depth (cm)	
OZ 34/1	0-3	10YR 2.5/1 (black) with common medium faint dark grey and brown mottles; silty clay; moderate fine subangular blocky; few fine pores; moist and slightly friable; common medium cohune and few fine roots; few fine soft white calcareous patches; rare fine black manganiferous concretions; clear regular boundary to:
OZ 34/1 (cont.)	3-22	10YR 4/2 (dark greyish brown); clay; moderate coarse breaking to moderate medium subangular blocky with few discontinuous pressure faces; few medium pores; moderate and firm, slightly plastic and slightly sticky; common-few medium palm and fine roots; few fine black manganiferous concretions; gradual regular boundary to:
OZ 34/2	22-72	N4/. (dark grey) with many medium distinct dark brown mottles; clay; weak medium breaking to moderate fine angular blocky with moderate fairly common pressure faces and few strong slickensides; few medium and fine pores; moist-wet and slightly firm, plastic and sticky; few medium palm roots; few fine white soft calcareous patches; clear regular boundary to:
OZ 34/3	72-140	N4/. (dark grey) with many fine faint dark brown mottles; clay; strong medium wedge-angular blocky with abundant strong slickensides; many fine pores; moist-dry and extremely firm; rare fine roots; common very fine soft white calcareous patches and grit and shell fragments; rare fine black manganiferous concretions.
Continued by auger:		
	140-150	As above
	150-160	Olive yellow clay; moist-dry and firm; common fragments of limestone
	160+	Hard flat white limestone

Note: Augerings in the vicinity showed depths to stones or rock of 50, 60, 70 and 120 cm. This pit appears to be in a particularly deep pocket. The slightly acid pH's and less than total base saturation suggest that this soil is leached and probably fairly old.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-5	8967	1	1	3	1	9	12	73	6.0	4.8	0.15	10.9	0.52	3.87	7	2	–	1.02
22-72/84	8968	2	1	2	3	2	11	79	5.9	4.0	0.05	12.2	0.10	0.72	7	2	–	1.06
72-140	8969	1	1	3	3	4	8	80	6.1	4.7	0.15	12.0	0.06	0.58	10	3	–	1.02

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-5	8967	0.3	0.3	6.9	45.6	–	53.1	57.7	92	250	750	5,650	9,500	40	2,040	100	–
22-72/84	8968	0.6	0.1	4.2	42.5	–	47.4	58.1	82	110	700	5,550	8,600	40	1,770	80	–
72-140	8969	1.2	0.1	3.8	48.2	–	53.3	57.1	93	80	750	5,300	9,500	30	1,100	90	–

Soil Classification	Suite Yaxa	Subsuite Chacluum
Soil correlation	FAO/UNESCO Chromic Eutric Cambisol	USDA Soil Taxonomy Rhodudalfic Eutropept

Described: 31.8.89

Location: 1.5 km south of road from Gallon Jug to Hill Bank (16Q BQ 927 410)

Landform: Crest of gentle rise in undulating plain in Hill Bank Plain land system

Parent Material: Cretaceous limestone

Vegetation: High broadleaf bush with allspice, gombolimbo, santa maria and botan

Site Drainage: Good

Surface: 2-3 cm continuous leaf litter

Sample no.	Depth (cm)	
OZ 35/1	0-6	7.5YR 3/2 (dark brown); very slightly gritty silty clay; moderate fine subangular blocky breaking to moderate fine crumb; few medium pores; moist-wet, slightly plastic and slightly sticky; abundant medium and fine roots; common fine calcareous grit; rare fine black manganiferous concretions; gradual regular boundary to:
	6-17	5YR 5/4 (reddish brown) with common medium fine 2.5YR 5/8 (red) mottles; very slightly gritty clay; moderate medium-fine subangular blocky with common moisture films and few weak discontinuous clayskins; few fine pores; moist and slightly friable; many medium and fine roots; few fine calcareous grit; common fine black manganiferous concretions; gradual regular boundary to:
OZ 35/2	17-28	2.5YR 5/6 (red); gritty clay; stony – moderate fine subangular blocky, with weak discontinuous clayskins and common moisture films; few fine pores; moist and slightly friable; common medium roots; abundant fine slightly hard calcareous grit and few limestone stones; common fine and medium black manganiferous concretions; clear regular boundary to:
	28-35	Discontinuous stone line of hard fine sandy limestone with abundant glittering microcrystals of ? calcite.
	35-40+	White slightly hard massive limestone with common softer reddish brown patches.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-6	8971	2	3	3	3	5	13	71	6.8	6.0	0.22	10.4	0.65	6.15	9	2	4	0.93
17-28	8970	12	3	4	2	3	9	67	7.4	6.4	0.27	7.2	0.21	1.42	7	3	1	1.07

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-6	8971	0.1	0.8	3.6	49.9	–	54.4	51.1	99	210	800	3,200	11,000	30	1,560	90	–
17-28	8970	0.5	0.1	1.4	33.4	–	35.4	34.3	100	110	450	3,000	9,300	30	1,390	50	1.0

Soil Classification	Suite Chacalte > Stopper	Subsuite Xpicilha > Pinol
Soil correlation	FAO/UNESCO Haplic Luvisol	USDA Soil Taxonomy Haplic Tropudalf

Described: 5.9.89

Location: 1 km south of Augustine on Chiquibul Road (16Q BP 880 764)

Landform: Gentle (3 degrees) slightly concave lower slope of prominent hill of low karst in Vaca Hills land system

Parent Material: Coban Formation limestone with some granitic wash

Vegetation: Old secondary forest with wild yams, red gombolimbo, trumpet; and basket, broom and botan palms

Site Drainage: Good

Surface: 1-3 cm of continuous leaf litter

Sample no.	Depth (cm)	
OZ 36/1	0-11	7.5YR 3/2 (dark brown); medium sandy loam-sandy clay loam; weak medium subangular breaking to weak fine subangular blocky; common fine pores; moist and friable; many fine and common medium roots; few angular quartz grit; worms seen; common patches of white hyphae; clear regular boundary to:
OZ 36/2	11-32	7.5YR 5/6 (strong brown); medium sandy clay; moderate medium angular blocky; common medium pores; moist and friable, slightly plastic and non-sticky; common medium and fine roots; few subrounded quartz stones and angular quartz grit; few soft black manganiferous concretions; clear regular boundary to:
OZ 36/3	32-80/85	10YR 5/6 (yellowish brown) with many medium distinct red and yellowish red mottles; slightly gritty clay; weak coarse breaking to weak-moderate fine angular blocky with weak discontinuous clayskins; common fine pores; moist and slightly friable, and slightly plastic but non-sticky; common medium and fine roots; common quartz stones and grit as in above horizon; few soft black manganiferous concretions especially concentrated towards base of horizon; gradual slightly wavy boundary to:
OZ 36/4	80/85-100+	10YR 7/2 (light grey) with many fine faint pale brown, yellow and grey mottles; bouldery clay; interstitial fine earth is massive weak medium-fine angular blocky with moderate discontinuous clayskins; few medium and fine pores; moist and firm; rare fine roots; common subrounded white limestone stones and boulders, up to 30 cm diameter; many soft black manganiferous concretions.

Note: The increasing limestone contribution with depth shows clearly in the pH and Ca levels.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-11	8972	9	16	20	14	13	7	21	6.5	5.7	0.10	2.6	0.21	2.23	11	2	2	1.11
11-32	8973	11	9	12	10	7	7	44	6.6	5.1	0.04	3.7	0.08	0.55	7	2	1	1.08
32-80	8974	9	5	9	6	6	9	56	5.8	4.4	0.03	4.5	0.05	0.36	7	2	1	1.14
85-100	8975	3	3	4	4	2	7	77	8.5	7.3	0.14	8.2	0.04	0.32	8	4	1	1.14

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-11	8972	0.0	0.1	1.6	13.4	–	15.1	16.3	93	170	1,450	950	2,750	10	870	50	–
11-32	8973	0.0	0.1	1.5	10.9	–	12.5	14.5	86	130	2,250	1,700	2,400	20	480	70	–
32-80	8974	0.1	0.1	0.8	10.2	–	11.2	15.4	73	110	3,050	1,700	2,050	20	250	80	–
85-100	8975	0.1	0.3	0.7	44.2	–	45.3	34.5	100	90	3,700	3,650	20,350	40	700	100	3.5

Soil Classification	Suite Vaca	Subsuite Cuxu
Soil correlation	FAO/UNESCO Chromic Cambisol	USDA Soil Taxonomy Chromudertic Eutropept

Described: 4.9.89

Location: New Maria Camp on Chiquibul Road (16Q BP 849 611)

Landform: Gentle (4 degrees) rectilinear midslope in undulating plain with low karst in Xpicilha Hills with Plains land system

Parent Material: Coban Formation limestone

Vegetation: High broadleaf bush with many cohunes, allspice and springstem palms

Site Drainage: Good

Surface: 2-3 cm of continuous leaf litter

Sample no.	Depth (cm)	
OZ 37/1	0-2	5YR 2.5/2 (dark reddish brown); clay loam; moderate fine subangular blocky-medium crumb; many medium pores; moist and slightly firm; abundant fine and medium roots; worms seen; abundant white hyphae; clear regular boundary to:
OZ 37/1 (cont.)	2-17	5YR 3/2 (dark reddish brown); clay; strong medium angular-subangular blocky with weak medium clayskins; common coarse and medium pores; moist and firm; many medium and fine roots; abundant white hyphae in all voids and penetrating some peds; few soft black manganiferous concretions; clear regular boundary to:
OZ 37/2	17-53	5YR 4/2 (dark reddish grey); clay; moderate medium breaking to moderate fine angular blocky, with weak continuous clayskins and some weak pressure faces; common medium pores; moist and firm and slightly sticky; common medium and fine roots; few fine and medium fragments of hard white limestone; clear regular boundary to:
OZ 37/3	53-80+	5YR 5/6 (yellowish red); bouldery gritty clay; moderate medium-fine angular blocky with weak but continuous pressure faces; common fine pores; moist and interstitital fine earth is very firm; few common fine roots; many round hard white limestone boulders and stones.

Note: The slightly lower pH and Ca levels in the middle horizon are thought to indicate the high intensity of leaching. The higher levels in the topsoil are attributed to biological recycling of Ca, and those in the lowest horizon to the proximity of the limestone.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-17	8976	2	1	2	2	4	14	75	8.0	7.1	0.26	11.5	0.61	5.51	9	3	3	0.99
17-53	8977	6	1	2	2	2	11	76	6.6	5.2	0.07	9.8	0.25	1.51	6	3	1	1.05
53-80	8978	7	3	3	3	7	14	63	8.5	7.4	0.18	8.3	0.11	0.60	5	3	2	1.15

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-11	8976	0.4	0.5	3.8	>50.0	–	>54.7	61.7	>89	270	800	4,400	14,700	40	780	60	–
17-53	8977	0.0	0.1	0.6	41.3	–	42.0	45.4	93	180	550	3,850	8,550	40	790	60	–
53-80	8978	0.0	0.2	0.2	>50.0	–	>50.4	35.9	100	120	1,050	4,550	128,100	30	370	40	21.0

Soil Classification	Suite Stopper	Subsuite Pinol
Soil correlation	FAO/UNESCO Haplic Ferralsol	USDA Soil Taxonomy Hapludox

Described: 5.9.89

Location: Navel Road, Mountain Pine Ridge (16Q BP 955 779)

Landform: Gentle (1-2 degrees) rectilinear midslope on undulating granite plateau in Mountain Pine Plateau land system

Parent Material: Granite

Vegetation: Mountain Pine Ridge with many pines (*Pinus caribaea*), crabboo and thick cover of Mountain Pine Ridge grass

Site Drainage: Good

Surface: 2-5 cm of dry grass and pine needle litter

Sample no.	Depth (cm)	
0Z 38/1	0-5	N5/. (grey) with common medium faint light greyish brown mottles; silty clay loam; weak medium subangular blocky breaking to weak fine crumb; many fine pores; moist and friable; common medium and fine roots; no worms; clear slightly wavy boundary to:
	5-17	10YR 5/4 (yellowish brown) with common fine faint greyish brown mottles; gritty clay loam; weak medium slightly angular blocky breaking to weak fine crumb; many coarse and medium pores; moist and friable; common medium and fine roots; many bleached angular quartz grit; few larvae; gradual regular boundary to:
OZ 38/2	17-28	7.5YR 5/8 (strong brown) with many fine faint yellow, pale yellow, and yellowish red mottles; gritty clay; weak fine angular blocky breaking to weak fine crumb with very weak and discontinuous clayskins; few fine pores; moist and slightly friable; common medium roots; many angular quartz grit, less bleached than in horizon above; diffuse boundary to:
OZ 38/3	28-100+	5YR 5/8 (yellowish red) with abundant medium distinct reddish yellow and pale yellow mottles; gritty clay; weak coarse breaking to moderate fine angular blocky; few fine pores; moist and compact *in situ* but very friable in the hand; rare fine roots down to 70 cm but absent thereunder except in vein; quartz grit throughout; steeply inclined double line of angular quartz stones following line of old vein; adjacent fine earth is paler than rest of horizon – 7.5YR 7/6 (reddish yellow); fine roots run in the narrow (few mm) space between the two lines and give a darker coloured core.

Note: The persistence of the quartz vein to within 30 cm of the surface suggests that most of the profile developed by *in situ* weathering.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-5	8979	16	10	8	3	3	12	48	4.9	4.0	0.06	2.5	0.18	2.88	16	2	–	0.84
17-28	8980	21	7	5	3	4	12	48	5.3	4.5	0.05	1.6	0.06	0.90	15	1	–	1.00
30-60	8981	22	4	3	4	6	23	38	5.2	4.3	0.03	1.8	0.0	0.03	–	1	–	0.97

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-5	8979	0.0	0.1	0.2	1.0	4.3	1.3	10.5	12	110	1,650	350	100	10	60	30	–
17-28	8980	0.1	0.0	0.1	0.8	1.2	1.0	3.7	27	80	1,000	200	100	10	40	20	–
30-60	8981	0.1	0.0	0.1	0.2	1.9	0.4	4.0	10	80	2,000	250	<25	10	20	30	–

Soil Classification	Suite Ossory	Subsuite Chiquibul
Soil correlation	FAO/UNESCO Skeletal Dystric Cambisol	USDA Soil Taxonomy Dystropept

Described:	5.9.89
Location:	Codd Line, close to Navel Road, Mountain Pine Ridge (16Q BP 984 774)
Landform:	Fairly gentle (6 degrees) convex-rectilinear upper slope with 21 degrees gradient close downhill in metasedimentary valleys subunit in Mountain Pine Plateau land system
Parent Material:	Vertically bedded sandstone and argillite of Santa Rosa Group
Vegetation:	Fairly open Mountain Pine Ridge, with medium size pines (*Pinus caribaea*) and few small crabboo with rather thin cover of Mountain Pine Ridge grass. Patch of tiger bush upslope
Site Drainage:	Good
Surface:	Discontinuous litter layer up to 3 cm thick; many angular hard quartz and few sandstone and argillite stones, up to 6 cm diameter

Sample no.	Depth (cm)	
0Z 39/1	0-10/15	10YR 5/4 (yellowish brown); very stony fine sandy clay loam; interstitial fine earth has weak fine crumb structure; many fine pores; moist and very friable; many fine and few medium pores; abundant – many subrounded fragments of red, brown and purple sandstone and angular quartzite stones; worms seen; gradual wavy boundary to:
OZ 39/2	10/15-52	10YR 7/8 (yellow) with common coarse distinct patches of 2.5YR 5/8 (red) colours in the weathering shale; stony fine sandy clay; weak coarse angular blocky with rare weak discontinuous clayskins; many medium and fine pores; moist and friable; few medium and common fine roots; few pieces of fairly hard sandstone and common patches of soft weathering shale, increasing to many with depth; clear slightly wavy boundary to:
	52-200+	Vertical hard beds of metasediments, with sandstones slightly predominant.

Note: Although the general nutrient status of this soil is as low as those of the granitic soils, the total contents of K are considerably higher. The exchangeable K figures suggest that little of this K is available in the short term.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-10	8982	19	3	16	17	15	17	13	5.4	4.4	0.06	1.3	0.09	1.48	16	3	–	1.12
15-52	8983	0	0	4	11	13	50	22	5.2	4.6	0.03	0.7	0.02	0.26	13	0	–	1.03

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			%
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	$CaCO_3$
0-10	8982	0.1	0.1	0.1	0.5	1.1	0.8	4.6	17	530	10,250	300	150	10	30	40	–
15-52	8983	0.0	0.0	0.0	0.2	0.3	0.2	1.3	15	160	22,400	450	50	10	10	10	–

Soil Classification	Suite Stopper	Subsuite Pinol
Soil correlation	FAO/UNESCO Haplic Acrisol	USDA Soil Taxonomy Hapludult
Described:	6.9.89	
Location:	Cooma Cairn road, 0.5 km from Main Gate-Augustine Road (16Q BP 932 859)	
Landform:	Very gentle (1 degree) midslope in undulating section of granite plateau in the Mountain Pine Plateau land system	
Parent Material:	Granite	
Vegetation:	Thick Mountain Pine Ridge, with dense stand of tall pines, many *Hypericum* sp. shrubs and thick cover of Mountain Pine Ridge grass	
Site Drainage:	Good	
Surface:	4-6 cm of needle and grass litter; common fine pieces of charcoal	

Sample no.	Depth (cm)	
0Z 40/1	0-11	2.5YR 4/2 (weak red) with common medium faint patches of 2.5YR 4/6 (red); very slightly gritty clay; moderate fine angular blocky breaking to moderate fine crumb; common fine pores; moist and slightly friable; common medium and fine roots; common fine angular quartz grit; rare black manganiferous concretions; diffuse boundary to:
OZ 40/2 (40-50)	11-75	10R 5/4 (weak red); very slightly gritty clay; weak coarse subangular blocky breaking to weak fine crumb; many fine pores; moist and very friable; common medium and fine roots decreasing to few; rare quartz stones and few angular quartz grit; few rounded black manganiferous concretions; diffuse boundary to:
	75-115+	10YR 4/8 (red) with prominent coarse lattice zones of 7.5YR 7/8 (reddish yellow); coarse sandy clay – weathering granite; massive – weak medium angular blocky; common fine pores; moist and fragic, compact and indurated *in situ*, but friable and crumbly when disturbed; rare fine roots; angular quartz stones and patches of very quartzose weathering granite increasing in frequency and hardness with depth; rare black manganiferous concretions.

Note: This is an example of the red variant of Pinol. The clay content is higher than in the modal type (e.g. 0Z 38), as are the pH and base status. The difference is mainly due to the higher Ca status of this soil.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-11	8984	13	10	10	7	6	10	44	5.9	4.7	0.05	3.1	0.14	2.90	21	2	–	1.00
40-50	8985	12	4	6	4	4	6	64	5.7	5.5	0.04	1.7	0.02	0.22	11	1	–	0.98

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-11	8984	0.1	0.1	0.8	3.2	–	4.2	10.6	40	190	1,150	550	700	30	240	40	–
40-50	8985	0.1	0.0	0.4	0.8	–	1.3	2.3	57	150	1,200	450	100	40	50	30	–

Soil Classification	Suite Stopper	Subsuite Pinol
Soil correlation	FAO/UNESCO Haplic Acrisol	USDA Soil Taxonomy Hapludult

Described: 7.9.89

Location: 1.5 km north-west of Guacamallo Bridge (16Q BP 841 663)

Landform: Gentle (4 degrees) convex upper slope of granite plateau in Mountain Pine Plateau land system

Parent Material: Granite

Vegetation: Mountain Pine Ridge with pines (*Pinus caribaea*), crabboo, oak, and thick cover of Mountain Pine Ridge grass

Site Drainage: Good

Surface: 3 cm needle and grass litter

Sample no.	Depth (cm)	
0Z 41/1	0-12	10YR 5/1 (grey); loamy grit and gravel; mostly single grain with pockets of weak fine crumb in finer material; moist and friable; many medium and fine roots; few coarse stones of quartz and ferruginised granite, and abundant bleached angular quartz grit and gravel; clear regular boundary to:
	12-28	2.5Y 7/6 (yellow) with few reddish yellow gravel fragments; extremely gritty clay loam; very weak medium angular blocky breaking to single grain; many fine pores; moist and friable; common medium and fine roots; many angular bleached quartz grit; gradual regular boundary to:
OZ 41/2	28-50	2.5YR 7/4 (pale yellow) with many medium fairly distinct orange, reddish yellow, reddish brown and a few grey mottles; very gritty clay loam; weak medium angular blocky with rare weak clayskins; many fine pores; moist-wet and friable, very slightly plastic but not sticky; few fine roots; many grit and few quartz stones; gradual regular boundary to:
OZ 41/3	50-94	2.5Y 8/2 (white) matrix and all ped exteriors, with many medium prominent red, reddish yellow, yellow, and brown mottles in ped interiors; gritty clay loam – weathering granite; weak coarse breaking to weak fine angular blocky with weak continuous clayskins on vertical faces but only discontinuous on horizontal faces; abundant fine pores; moist-wet and compact but crumbles to friable in the hand, very slightly plastic but not sticky; rare fine roots; many quartz grit; diffuse boundary to:
	94-150+	Slightly hard brown yellow, white and reddish yellow (but not red) weathering granite; apparently porphyritic texture with large soft flecks of ? kaolinized feldspars.

Note: This is an example of the pale-coloured, coarse-textured Pinol soils. The nutrient levels are generally low, especially for N, total P and Cu, but total K is high in all horizons and available P (Bray) is moderate in the topsoil.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-12	8986	44	10	13	7	6	8	12	5.5	4.4	0.05	1.1	0.08	1.32	16	6	–	1.20
28-50	8987	32	13	11	5	6	14	19	5.4	4.3	0.03	0.9	0.02	0.18	9	1	–	1.14
50-94	8988	28	18	10	4	4	17	19	5.2	4.1	0.02	1.4	0.02	0.12	6	1	–	1.15

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-12	8986	0.0	0.2	0.2	0.6	1.5	1.0	4.5	22	50	4,400	800	100	<5	30	20	–
28-50	8987	0.1	0.1	0.2	0.3	2.6	0.7	3.5	20	30	6,600	1,250	<25	<5	30	20	–
50-94	8988	0.1	0.2	1.1	0.2	3.4	1.6	6.1	26	100	12,100	2,450	<25	10	40	30	–

Soil Classification	Suite Ossory	Subsuite Cooma
Soil correlation	FAO/UNESCO Plinthic Cambisol	USDA Soil Taxonomy Plinthic Dystropept
Described:	8.9.89	
Location:	East of 1000 Foot Falls turnoff on Cooma Cairn Road (16Q CP 007 838)	
Landform:	Gentle (3 degrees) rectilinear midslope in rolling part of metasedimentary plateau in Mountain Pine Plateau land system	
Parent Material:	Santa Rosa Group argillite	
Vegetation:	Fairly dense Mountain Pine Ridge, with pines, crabboo, some Mountain Pine Ridge grass and much tiger bush	
Site Drainage:	Good	
Surface:	3-8 cm of litter, mostly needles	

Sample no.	Depth (cm)	
	6-3	Dry needles
	3-0	Dark brown slightly humified fibrous needle and grass litter
OZ 42/1	0-10	10YR 4/3 (brown – dark brown); fine sandy loam-clay loam; weak medium subangular blocky breaking to fine crumb; many fine pores; moist and very friable; abundant coarse, medium and fine roots; clear regular boundary to:
	10-21	7.5YR 7/8 (reddish yellow); fine sandy clay loam; moderate medium angular blocky; abundant fine pores; moist and slightly firm, tending to friable in disturbed samples; few medium and common fine roots; few angular quartz stones; few rounded black manginferous concretions; clear regular boundary to:
	21-25	Discontinuous line of subrounded slightly hard black, dark brown, and dark red ferrimanganiferous concretions, many with cores of fragments of weathering argillite, set in a matrix of fine earth as in above horizon:
OZ 42/2	25-43	10YR 7/8 (yellow) and 7.5YR 7/8 (reddish yellow) with common fine faint pale yellow and yellowish red mottles; slightly gravelly very fine sandy clay; massive breaking to weak medium angular blocky, with rare very weak clayskins; abundant fine pores which tend to be clumped; moist and slightly firm; few fine roots; many soft randomly oriented fragments of red, yellow, orange and purple weathering argillite; rare very black manganiferous concretions; clear slightly wavy boundary to:
	43-110+	Vertically bedded *in situ* weathering argillite and subordinate sandstone; bluish grey where fresh going to red, yellow, orange and pale yellow; softest patches are: 5YR 6/8 (reddish yellow) with many medium and coarse red and yellow mottles; medium sandy loam; weak coarse angular blocky-prismatic, with weak discontinuous clayskins; common fine pores; moist and slightly firm; few fine roots.

Note: The layer of concretions is rather deeper and less pronounced than in many of the other soils from metasediments in this part of the Mountain Pine Plateau. Note also that the tendency towards prismatic structure as seen in the soils of the Bald Hills at higher altitudes (e.g. OZ 43) is also slightly apparent here. There are high total K levels, as found in other metasedimentary soils. The very low Mn levels are inexplicable in view of the abundant black concretions, which are assumed to be manganiferous as well as ferruginous.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-10	8989	1	3	9	12	13	32	30	4.6	4.0	0.05	3.0	0.20	3.68	18	1	–	0.75
25-43	8990	3	1	3	6	6	62	19	5.3	4.6	0.03	0.9	0.05	0.44	9	0	–	0.88

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			%
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	$CaCO_3$
0-10	8989	0.1	0.1	0.1	0.2	4.6	0.5	13.9	4	170	13,200	650	<25	10	10	10	–
25-43	8990	0.0	0.0	0.0	0.3	0.3	0.3	2.0	15	200	15,800	450	<25	10	10	10	–

Soil Classification	Suite Ossory	Subsuite Baldy
Soil correlation	FAO/UNESCO Haplic Acrisol	USDA Soil Taxonomy Hapludult
Described:	8.9.89	
Location:	Baldy Beacon Road (16Q CP 069 806)	
Landform:	Convex upper slope (gradient 5 degrees) of rounded ridge in rolling high plateau in Mountain Pine Plateau land system	
Parent Material:	Quartzite and argillite of Santa Rosa Group	
Vegetation:	Open grassland with rare stunted pine and crabboo	
Site Drainage:	Good-slightly impeded	
Surface:	1-2 cm grass litter, and more or less continuous single layer of quartz stones up to 5 cm diameter	

Sample no.	Depth (cm)	
OZ 43/1	0-7	10YR 5/2 (greyish brown); stony gritty loam; stony structure with interstitial weak medium crumb; moist-wet, consistence stony; many fine roots; abundant angular quartz grit and stones up to 5 cm; clear regular boundary to:
	7-16	2.5Y 7/4 (pale yellow); loamy grit; stony structure with interstitial weak fine subangular blocky; few fine pores; moist, indurated consistence due to stones; common fine roots; many quartz stones; clear regular boundary to:
	16-27	2.5Y 7/4 (pale yellow); silty clay; moderate coarse-medium angular blocky, with moderate continuous 2.5Y 8/4 (pale yellow) clayskins; few medium pores; moist and slightly firm; common fine roots; rare very fine black ferrimanganiferous concretions; few extremely fine mica flakes; clear regular boundary to:
OZ 43/2	27-44	10YR 7/4 (very pale brown) with many medium faint reddish yellow, yellowish red and brown mottles; slightly gritty silty clay; moderate coarse angular blocky-prismatic, with moderate continuous 2.5Y 7/4 (pale yellow) clayskins, especially on vertical faces; many very fine pores; moist and slightly firm; rare fine roots; common angular quartz grit and common slightly hard weathering argillite stones; common medium black ferrimanganiferous concretions; diffuse boundary to:
OZ 43/3	44-65	Mixed 10YR 7/6 and 10YR 8/6 (both yellow) and 10YR 7/1 (light grey); silty clay; moderate coarse prismatic, with strong continuous 2.5Y 8/4 (pale yellow) clayskins; common very fine pores; moist-dry, firm to slightly friable; rare fine roots; few fine slightly hard fragments of weathering shale, aligned vertically and apparently *in situ*; diffuse boundary to:
	65-100+	Vertically bedded grey, red and yellow weathering argillite, with reddish colours most apparent near the top; light grey clayskins down bedding planes; rare roots; subordinate sandstone is more weathered than the argillite.

Note: As in profiles OZ 39 and OZ 42, the argillitic component gives relatively high total K contents, but these do not appear to affect exchangeable K. As in profile OZ 42 the occurrence of black apparently manganiferous concretions is inexplicably associated with low levels of perchloric acid-extractable Mn.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-7	8991	27	6	12	10	9	18	18	4.5	3.9	0.13	2.3	0.39	4.70	12	1	–	0.82
27-44	8992	6	3	4	3	4	51	29	4.8	4.1	0.04	1.0	0.17	0.65	4	0	–	0.84
44-65	8993	0	1	1	2	5	70	21	4.9	4.2	0.03	0.9	0.18	0.35	~ 2	0	–	0.79

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-7	8991	0.3	0.2	0.4	0.6	3.0	1.5	9.7	15	180	9,800	650	100	<5	10	10	–
27-44	8993	0.1	0.1	0.0	0.2	1.8	0.4	4.0	10	180	20,000	700	50	20	10	10	–
44-65	8993	0.0	0.0	0.0	0.0	2.1	0.0	4.9	0	160	26,400	850	50	20	10	10	–

Soil Classification	Suite Revenge	Subsuite Felipe
Soil correlation	FAO/UNESCO Eutric Planosol	USDA Soil Taxonomy Hapludalf

Described: 27.2.90

Location: 3.5 km north-west of Yo Creek (16Q CR 237 034)

Landform: 1 degree midslope on very gently undulating plain in San Felipe Plain land system

Parent Material: Old siliceous alluvium over limestone

Vegetation: Tree savanna with many palmetto, crabboo and calabash

Site Drainage: Imperfect

Surface: 0 – 0.5 cm discontinuous tree leaf litter; slight microrelief, amplitude 1-2 cm, around grass clumps

Sample no.	Depth (cm)	
OZ 44/1	0-12	10YR 4/1 (dark grey) with many fine greyish brown mottles; medium sandy loam; weak fine subangular blocky breaking to weak medium crumb; moist and friable; common pores; common medium roots, especially palmetto; clear regular boundary to:
OZ 44/2	12-25/65	10YR 7/3 (very pale brown) dry, 10YR 5/3 (brown) moist; loamy fine-medium sand; extremely weak medium subangular blocky breaking to single grain; moist and very friable; common pores; common palm roots; clear regular boundary to:
OZ 44/3	25/65 – 45/70	10YR 7/1 (light grey) with many fine prominent dark grey, reddish yellow and reddish brown linear mottles; fine sandy clay; moderate fine medium angular blocky, with common discontinuous clay and silt coatings; moist and firm; common pores; few palm roots; gradual regular boundary to:
	45-70	Discontinuous horizon; N6 (grey-light grey) with many fine distinct reddish brown mottles; medium sandy clay; moderate medium subangular blocky with moderate continuous clay and silt coatings; moist and slightly firm and slightly plastic; common medium pores; few palm roots; clear regular boundary to:
OZ 44/4	70-150+	5Y 8/2 (white) with common medium distinct reddish yellow and reddish brown mottles; fine sandy clay; massive breaking to moderate medium angular blocky with moderate discontinuous clayskins; common fine pores; moist, firm, plastic and slightly sticky; few palm roots; patches of bright red slightly hard weathering rock with white sugary quartz.

Samples sent to Central Farm.

Soil Classification	Suite Bahia	Subsuite Consejo
Soil correlation	FAO/UNESCO Skeletal Humic Cambisol	USDA Soil Taxonomy Skeletal Humitropept
Described:	28.2.90	
Location:	3 km west of Consejo (16Q CR 603 404)	
Landform:	Low gently undulating coastal plain in Consejo Plain land system	
Parent Material:	Coral gravel over gypsiferous limestone	
Vegetation:	Recently harvested sugar cane	
Site Drainage:	Good	
Surface:	Many coral gravel and stones	

Sample no.	Depth (cm)	
OZ 45/1	0-22	N2.5 (black); stony peaty loam; strong medium subangular blocky, with pressure faces against coral fragments; common fine pores; moist and slightly firm; common fine roots; abundant hard sharp angular coral gravel and stones; clear slightly wavy boundary to:
	22-29/35	10YR 3/2 (very dark greyish brown); stony clay; moderate medium subangular blocky, with discontinuous pressure faces; few medium pores; interstitial fine earth is moist and slightly firm; common fine roots; many hard sharp coral gravel and stones; clear wavy boundary to:
OZ 45/2	29/35-150+	10YR 8/4 very pale brown); friable sascab (gravelly clay loam texture), becoming firmer with depth; discontinuous lens of 10YR 7/3 (very pale brown) silty loam-silty clay loam; weak medium subangular blocky at 29-50.

Note: The 'sascab' below 30 cm is in fact mainly gypsum. This accounts for the very high total Ca, low $CaC0_3$ and low CEC.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Soluble cations me/100 g Na	Soluble cations me/100 g K	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-22	9804	12	2	3	2	2	21	58	7.7	7.3	1.84	0.0	0.0	10.6	0.69	5.20	8	10	2	0.96
50-60	9805	1	2	4	3	11	62	17	8.0	8.0	2.19	0.1	0.0	24.3	0.04	0.31	8	2	1	1.01

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-22	9804	0.0	1.2	3.8	>50.0	–	>55.0	49.3	100	260	9,500	15,050	130,450	20	390	30	26.5
50-60	9805	0.0	0.0	0.5	>50.0	–	>50.5	0.5	100	20	50	300	276,950	10	10	10	3.0

Soil Classification	Suite Pembroke	Subsuite Louisville
Soil correlation	FAO/UNESCO Pelli-eutric vertisol	USDA Soil Taxonomy Pelludert

Described: 1.3.90

Location: Santa Rosa area, 6 km west-north-west of Chan Chen (16Q CR 441 420)

Landform: Very gently undulating plain in Louisville Plain land system

Parent Material: Limestone

Vegetation: Low sclerophyllous bush with chechem, gombolimbo, botan

Site Drainage: Good

Surface: Continuous litter of dry leaves

Sample no.	Depth no. (cm)	
0Z 46/1 (0-15)	0-6	5YR 2.5/1 (black); clay; strong fine subangular blocky; few fine pores; dry and hard; abundant medium and fine roots; clear regular boundary to:
OZ 46/1 (cont)	6-22	5YR 3/1 (very dark grey); clay; strong coarse to medium subangular blocky, with moderate pressure faces; few fine and medium pores; moist-dry and very firm; common coarse, medium and fine roots; common dark infilled faunal channels up to 2 cm diameter; gradual regular boundary to:
OZ 46/2	22-92	10YR 6/1 (grey-light grey); clay; strong medium subangular blocky with strong pressure faces; few medium and fine pores; moist and extremely firm; few medium palm roots; common coarse patches of 10YR 8/2 (white) clay with pockets of crumbly sascab; clear slightly wavy boundary to:
	92-120	10YR 8/2 (white) with few very fine very faint reddish yellow mottles; clay; strong coarse subconchoidal subangular blocky, with strong pressure faces, some striated; few fine pores; moist and very firm; few medium palm roots; few patches of soft white sascab; gradual regular boundary to:
OZ 46/3	120-130+	10YR 8/2 (white); soft sascab (silty clay texture); moderate fine-medium subangular blocky; few fine pores; moist and friable; rare medium palm roots; common patches of harder limestone; many medium gypsum crystals.

Samples sent to Central Farm.

Soil Classification	Suite Yaxa	Subsuite Ramgoat
Soil correlation	FAO/UNESCO Chromic Luvisol	USDA Soil Taxonomy Rhodudalf

Described: 5.3.90

Location: 4 km north of Irish Creek crossing on Hill Bank-San Felipe road (16Q CQ 162 505)

Landform: Flat plain in Hill Bank Plain land system

Parent Material: Slightly tuffaceous Cayo Group limestone

Vegetation: Logged high bush with common mahogany, sapote, cohune, and few botan and pucte

Site Drainage: Good

Surface: 1-3 cm continuous leaf litter

Sample no.	Depth (cm)	
OZ 47/1	0-4	5YR 3/3 (dark reddish brown); clay; strong fine subangular blocky; few medium pores; moist-dry and firm-hard; common fine and medium roots; common earthworms; clear regular boundary to:
OZ 47/1 (cont.)	4-22	5YR 4/3 (reddish brown); clay; strong medium angular blocky with weak discontinuous clayskins; common medium pores; moist-dry and very firm – hard; common medium and coarse roots; rare black hard round manganiferous concretions; worms; gradual regular boundary to:
OZ 47/2	22-56	5YR 4/4 (reddish brown); slightly gravelly clay; moderate medium angular blocky with moderate discontinuous clayskins; common medium pores; moist and highly fragic; common medium and fine roots; many round hard black manganiferous concretions, and few fragments of coalesced dark reddish brown ferricrete; gradual regular boundary to:
OZ 47/3	56-90+	7.5YR 7/8 (reddish yellow) with common fine faint yellowish red mottles; clay; moderate medium-fine angular blocky with weak discontinuous clayskins; many fine pores; moist-dry and extremely indurated (slightly fragic); common medium roots; common medium hard round black manganiferous concretions; few worms.

Note: All of this profile was extremely difficult to dig. This appears to be a feature of Ramgoat as other sites were extremely difficult to auger. Despite their induration, the subsoils appear to have considerable biological activity, as indicated by the roots, worms and moderate organic C and total N levels.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-22	9806	3	2	2	1	2	13	77	5.8	5.7	0.19	4.5	0.40	2.77	7	3	–	0.95
22-56	9807	28	3	3	2	1	7	56	5.9	5.5	0.14	3.0	0.14	0.85	6	2	–	0.96
56-90	9808	3	0	1	0	0	7	89	5.9	5.9	0.05	3.0	0.06	0.21	4	1	–	0.98

		Exchangeable cations me/100 g a.d.s.								Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-22	9806	0.0	0.1	2.5	17.8	–	20.4	21.1	97	200	650	2,000	3,500	70	1,670	150	–
22-56	9807	0.0	0.1	1.4	6.6	–	8.1	9.6	84	230	400	1,650	1,500	90	1,450	230	–
56-90	9808	0.0	0.0	1.4	5.5	–	6.9	9.8	70	80	400	1,250	1,150	60	260	120	–

Soil Classification	Suite Tintal	Subsuite Pucte
Soil correlation	FAO/UNESCO Eutric Gleysol	USDA Soil Taxonomy Eutric Tropaquept
Described:	6.3.90	
Location:	2 km west of Orange Walk Town on Yo Creek road (16Q CQ 324 997)	
Landform:	Lower slope in Lazaro Plain land system	
Parent Material:	Tower Hill Formation limestone	
Vegetation:	Secondary swamp forest with occasional large pucte trees	
Site Drainage:	Poor	
Surface:	0-2 cm discontinuous leaf litter; marked hogwallow microrelief with amplitude up to 10 cm	

Sample no.	Depth (cm)	
0Z 48/1	0-18	10YR 4/1 (dark grey); silty clay loam; weak fine subangular blocky-crumb; common fine pores; moist-wet, friable, slightly plastic and non-sticky; many fine and medium roots; gradual regular boundary to:
OZ 48/2	18-60	N6 (grey-light grey) with few medium very faint pale brown and yellow mottles; fine silty clay; moderate medium subangular breaking to moderate fine angular blocky, with continuous moisture films; few medium pores; moist-wet, friable, slightly plastic and non-sticky; common medium roots; worms seen; diffuse boundary to:
OZ 48/3	60-93	5Y 8/2 (white) with many fine distinct linear reddish brown and brown mottles; clay; moderate medium angular blocky, with moderate continuous clayskins; moist and slightly firm; common fine reddish brown roots; abundant fine gypsum crystals; slight H_2S smell; diffuse boundary to:
OZ 48/4	93-145+	2.5Y 8/2 (white) with many fine distinct yellow and few coarse distinct reddish brown mottles; clay; coarse medium angular blocky with slight tendency to wedge, with strong continuous clayskins, especially thick and pale brown in colour on upper oblique faces; few fine pores; moist and firm; few fine roots; abundant fine gypsum crystals; no H_2S smell.

Note: The lower horizons are drier than those above, suggesting that shallow throughflow is an important pathway for water in this soil. This swamp is clearly fed by saline and sulphidic groundwater. The lower moisture contents in the subsoil have led to natural oxidation and acidification. The high Ca levels are derived from sulphides and sulphates, not carbonates.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Soluble cations me/100 g Na	Soluble cations K	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-18	9809	1	3	11	8	5	15	57	7.5	7.2	1.27	0.8	0.0	9.2	0.48	4.23	9	17	2	1.04
18-60	9810	2	3	10	7	2	10	66	7.2	6.8	2.37	1.6	0.0	9.3	0.04	0.42	10	5	1	1.20
60-93	9811	1	3	8	6	3	13	66	3.8	3.7	3.37	2.5	0.0	15.1	0.01	0.13	13	2	1	1.09
120-130	9812	1	3	6	5	3	13	69	4.0	3.8	3.89	3.4	0.0	15.7	0.01	0.08	8	2	2	1.05

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-18	9809	1.4	0.2	7.8	>50.0	–	>59.4	51.5	100	230	450	6,200	22,050	20	100	40	–
18-60	9810	3.3	0.1	9.3	47.4	–	60.1	43.8	100	60	400	6,150	8,850	10	100	40	–
60-93	9811	3.1	0.0	7.8	>50.0	0.7	>60.9	20.6	100	30	300	3,850	112,300	10	50	30	–
120-130	9812	4.9	0.1	12.3	>50.0	0.4	>67.3	24.5	100	30	450	4,900	113,000	10	60	30	–

Soil Classification	Suite Altun Ha	Subsuite Jobo
Soil correlation	FAO/UNESCO Haplic Luvisol	USDA Soil Taxonomy Hapludalf
Described:	7.3.90	
Location:	1 km north of Bomba village (16Q CQ 653 794)	
Landform:	Flat plain in Jobo Plain land system	
Parent Material:	Doubloon Bank Group limestone	
Vegetation:	Plantation of bananas, corn and few interplanted citrus	
Site Drainage:	Good – slightly impeded	
Surface:	Discontinuous littter of banana leaves; occasional flint stones up to 20 cm across	

Sample no.	Depth (cm)	
0Z 49/1	0-15	5YR 2.5/1 (black); humose silty clay; moderate fine-medium subangular blocky; common fine and medium pores; moist and slightly friable; many medium and coarse old tree roots; few flint stones; many ants; clear regular boundary to:
OZ 49/2	15-42	7.5YR 4/2 (brown-dark brown) with many fine very faint reddish brown mottles; very stony clay; weak medium subangular blocky with weak discontinuous clayskins and moisture films; few fine pores; moist, plastic and slightly sticky; few medium roots; abundant coarse flint stones; gradual regular boundary to:
OZ 49/3	42-77	10YR 4/2 (dark greyish brown) with many very fine and very faint yellowish brown mottles; stony heavy clay; moderate coarse-medium angular blocky with strong continuous clayskins; few fine pores; moist, very plastic and sticky; few medium roots, many flint stones; abrupt slightly wavy boundary to:
OZ 49/4	77-97	2.5Y 7/4 (pale yellow) with many medium distinct reddish yellow, yellow and light grey mottles; heavy clay; moderate medium angular blocky with strong-moderate continuous clayskins; few medium pores; moist, very plastic and very sticky; rare medium roots; few flint gravel and rare stones; gradual regular boundary to:
	97-115	As above horizon except that structure, is finer, clayskins are less pronounced, pores decrease to common and there are abundant flint slabs up to 25 cm across aligned horizontally; clear regular boundary to:
	115+	White sticky sascab (silty clay texture) with many flint stones.

Samples sent to Central Farm.

Note: The redder colours of the top two horizons and the darkening below 42 cm suggest that this profile may be bisequent. The yellow of the lower subsoil are rather pale for Puluacax; and the abundant flints put this soil into the Jobo Subsuite.

Soil Classification	Suite Yaxa	Subsuite Jolja
Soil correlation	FAO/UNESCO Eutric Cambisol	USDA Soil Taxonomy Skeletal Rendoll

Described: 9.3.90

Location: 6 km south of Bedraan Ranch road end (16Q BQ 748 757)

Landform: Low plateau in undulating plain in Neustadt Plain land system. Gradient 0.5 degrees

Parent Material: Flinty Barton Creek Formation limestone

Vegetation: Logged moderately high bush with many sapote. Some grass and sedge ground cover

Site Drainage: Good

Surface: 1-2 cm continuous leaf litter. Many flints, up to 5 cm across

Sample no.	Depth (cm)	
OZ 50/1	0-9	10YR 3/2 (very dark greyish brown); slightly gritty clay; moderate fine subangular blocky-medium crumb, with weak discontinuous pressure faces; common fine pores; moist and slightly firm; many coarse, medium and fine roots; rare fine flint stones; many worms; clear regular boundary to:
OZ 50/2	9-36	10YR 5/2 (greyish brown) with few medium faint pale brown mottles; very gritty clay; moderate medium angular blocky with weak discontinuous clayskins; few fine pores; moist and firm, many medium and fine and few coarse roots; abundant angular quartz grit and few flint stones; many white hyphae; few worms; clear regular boundary to:
OZ 50/3	36-62	10YR 3/1 (very dark grey) with common medium faint brown mottles; clay; massive breaking to moderate fine angular blocky, with moderate continuous clayskins; few fine pores; moist and firm, plastic and slightly sticky; common medium roots; few flint gravel and rare flint stones; clear slightly wavy boundary to:
OZ 50/4	62-118	7.5YR 7/4 (pink) with many medium distinct dark brown and pale brown mottles; sandy clay (sascab); massive breaking to weak coarse angular blocky with strong discontinuous dark brown coatings; many fine pores; dry and slightly hard; few fine roots, rarer with depth; rare flint very fine gravel;
Continued by auger:		
	118-150	As above
	150-180+	Soft white dry powdery limestone.

Samples sent to Central Farm.

Soil Classification	Suite Pembroke	Subsuite Louisville
Soil correlation	FAO/UNESCO Pelli-eutric Vertisol	USDA Soil Taxonomy Pelludert

Described: 12.3.90

Location: 1 km north-north-west of Louisville (16Q CR 389 265)

Landform: Flat midslope area in very gently undulating plain in Louisville Plain land system

Parent Material: Orange Walk Group limestone

Vegetation: Low akalche bush with high proportion of white chechem, few pucte, gombolimbo trees, and common botan palm.

Site Drainage: Imperfect

Surface: Moderate hogwallow microrelief (amplitude up to 15 cm). Discontinuous leaf litter 0-2 cm

Sample no.	Depth (cm)	
0Z 51/1	0-14	7.5YR 3/2 (dark brown); humose clay loam; weak medium crumb; few medium pores; moist-wet, soft-friable; many coarse medium and fine roots; clear slightly wavy boundary to:
	14-22	7.5YR 4/2 (brown-dark brown), with many fine faint reddish brown mottles; silty clay-clay; weak medium subangular blocky with weak discontinuous clayskins; many medium and coarse pores; moist-wet, friable, slightly plastic and very slightly sticky; common medium and fine roots; clear slightly wavy boundary to:
OZ 51/2	22-28/56	N7 (light grey) with rare very fine faint reddish brown linear mottles; clay; weak medium angular blocky, with weak discontinuous clayskins; many medium pores; moist-wet, friable, slightly plastic and very slightly sticky; few fine and medium roots; clear very pocketed boundary to:
OZ 51/3	28/56-95	2.5Y 8/2 (white) with rare fine distinct reddish brown and reddish yellow linear mottles; clay; weak coarse angular blocky with strong continuous clayskins; few medium pores; moist, plastic and sticky; few fine roots; diffuse boundary to:
	95-115	Colour, mottles, texture and consistence as above horizon, but structure is more wedged and clayskins are striated in places (moderate slickensides), and roots decrease to rare
Continued by auger		
	115-160	As above
	160-200+	Creamy sascab, moist-wet, soft and friable.

Samples sent to Central Farm.

Soil Classification	Suite Pembroke	Subsuite Louisville
Soil correlation	FAO/UNESCO Rendzic Cambisol	USDA Soil Taxonomy Rendollic Eutropept
Described:	12.3.90	
Location:	4 km west-north-west of Louisville (16Q CR 363 273)	
Landform:	0.5 degree eastward-sloping crest of gentle swell on gently undulating plain in Louisville Plain land system	
Parent Material:	Orange Walk Group limestone	
Vegetation:	Disturbed secondary cohune ridge on edge of cane field, with cohune, trumpe, and some abandoned canes	
Site Drainage:	Good	
Surface:	Discontinuous litter of tree leaves, cane trash, cohune fronds, and occasional clusters of cohune nuts	

Sample no.	Depth (cm)	
0Z 52/1	0-10	N2 (black); clay; moderate medium crumb; common fine and medium pores; moist and very friable; many medium and fine roots; common fine slightly hard subrounded fragments of limestone; worms; clear regular boundary to:
OZ 52/2 (+ Kubiena sample)	10-25/29	10YR 2.5/1 (black); clay; moderate coarse subangular blocky, with moderate continuous pressure faces; many fine pores; moist and slightly firm; common coarse medium and fine roots; common medium and fine fragments of slightly hard-hard limestone gravel; clear slightly wavy boundary to:
OZ 52/3	25/29-48	10YR 4/2 (dark greyish brown), with common medium faint dark grey and brown patches; slightly gravelly clay; moderate coarse subangular blocky breaking to strong fine angular blocky, with strong discontinuous clayskins; many medium pores; moist and slightly firm; few fine roots; many subrounded angular fragments of slightly hard-hard limestone gravel; diffuse boundary to:
	48-78	7.5YR 8/2 (pinkish white), with common coarse faint pale brown patches; sascab (silty clay loam texture); tendency to subangular structure, easily crumbling to single grain; many fine pores; dry-moist and friable; rare cohune roots; patches of harder limestone; diffuse boundary to:
	78-90+	10YR 8/2 (white) with fewer pale brown patches than above; massive sascab; dry and slightly hard; no roots; many hard patches.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm^3 a.d.s.
0-10	9813	6	2	2	1	1	26	62	8.0	7.4	0.27	9.5	0.49	4.13	8	12	6	0.97
10-25	9814	9	2	2	2	1	21	63	8.1	7.3	0.18	10.0	0.33	2.70	8	12	4	1.00
30-48	9815	10	2	2	2	1	28	55	8.2	7.5	0.19	6.1	0.14	0.97	7	2	1	1.00

		Exchangeable cations me/100 g a.d.s.								Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-10	9813	0.0	2.5	4.6	>50.0	–	>57.1	46.0	100	680	8,050	9,350	176,700	30	540	50	37.5
10-25	9814	0.0	1.7	2.7	>50.0	–	>54.4	45.3	100	580	7,850	8,950	150,450	20	570	50	36.5
30-48	9815	0.1	0.6	1.3	>50.0	–	>52.0	27.2	100	260	4,300	6,600	235,500	10	320	30	55.5

Soil Classification	Suite Pembroke	Subsuite Concepcion
Soil correlation	FAO/UNESCO Rendzic Lithic Leptosol	USDA Soil Taxonomy Lithic Eutropept

Described: 13.3.90

Location: 1 km south-west of Libertad (16Q CR 453 239)

Landform: High flat area in gently undulating plain in Louisville Plain land system

Parent Material: Orange Walk Group limestone

Vegetation: Young ratoon cane, with grass weeds

Site Drainage: Good

Surface: Common slightly hard and hard limestone gravel and stones up to 5 cm across. Some cracks beginning to open (<5 mm). Residual microrelief from ridging up. Discontinuous litter of grass and cane trash

Sample no.	Depth (cm)	
0Z 53/1	0-6	N2 (black); clay; moderate fine crumb; few medium pores; moist and friable; common fine roots; few fine fragments of slightly hard limestone; worms seen; clear regular boundary to;
OZ 53/2	6-20	5YR 3/1 (very dark grey); clay; moderate medium subangular breaking to moderate fine angular blocky, with moderate discontinuous clayskins; common fine pores; moist and slightly firm; common fine roots; common fine slightly hard limestone gravel; common red Maya potsherds; clear slightly wavy boundary to:
	20-50+	Hard, horizontally laminated, white-creamy limestone carapace; with dark brown-grey soil down thin oblique cracks; with pockets of 10YR 5/3 (brown) clay; moderate fine crumb; moist and friable.

Samples sent to Central Farm.

Soil Classification	Suite Puletan	Subsuite Crooked Tree
Soil correlation	FAO/UNESCO Humic Podzol	USDA Soil Taxonomy Tropohumod
Described:	14.3.90	
Location:	4 km north of Crooked Tree Village (16Q CQ 357 696)	
Landform:	Upper slope of gently undulating island between lagoons in Crooked Tree Plain land system. Gradient ca 2 degrees to north-west	
Parent Material:	Deep siliceous alluvium	
Vegetation:	Pine Ridge with dense stand of oak, pine (*Pinus caribaea*) and wilding cashew. Few palmettoes. Very sparse grass cover due to shade	
Site Drainage:	Good	
Surface:	1-2 cm discontinuous pine needle and oak leaf litter. Much white sand surface showing	

Sample no.	Depth (cm)	
0Z 54/1	0-11	Mixed N4 (dark grey) and 10YR 7/2 (light grey); medium sand; single grain; slightly moist, extremely friable-loose; common coarse, medium and fine roots; gradual regular boundary to:
OZ 54/2	11-22/28	7.5YR 8/2 (pinkish white); medium sand; single grain; slightly moist, extremely friable-loose; few medium and fine roots; gradual slightly wavy boundary to:
OZ 54/3 (+ Kubiena sample)	22/28-32/39	Mixed 10YR 5/2 (greyish brown), and 10YR 5/3 (brown) and 10YR 6/3 (pale brown); medium sand; single grain; slightly moist, extremely friable-loose; few medium roots; diffuse boundary to:
	32/39-50/55	Mixed 10YR 7/3 (very pale brown) and 7.5YR 5/4 (brown) with common medium distinct 7.5YR 5/6 (strong brown) mottles; medium sand; single grain; slightly moist, extremely friable-loose; common-few medium roots; single flint stone; diffuse boundary to:
	50/55-83	10YR 7/3 (very pale brown) with rare fine faint pale yellow and reddish yellow mottles; medium sand; single grain; slightly moist, extremely friable-loose; few medium roots; diffuse boundary to:
OZ 54/4	83-120	10YR 8/2 (white); medium sand; single grain; slightly moist, extremely friable-loose; rare medium roots; gradual slightly wavy boundary to:
	120-136/150	10YR 8/3 (very pale brown) with rare fine faint reddish yellow mottles; medium sand; single grain; wet and loose; rare medium roots; clear slightly wavy boundary to:
OZ 54/5 (+ Kubiena sample)	136/150-180+	10YR 8/2 (white) with many coarse prominent 10YR 4/6 (red) with penumbra of reddish yellow, and yellowish red, plus many medium distinct grey and pale yellow mottles; medium sandy clay loam; moderate medium breaking to fine angular blocky, with moderate discontinuous clayskins; common medium and fine pores; moist and firm-very firm (almost indurated in places); rare medium pine roots; few rounded quartz grit

Note: This soil appears to be a very deep regosolic planosol, in the sandy top of which a degree of podzolization has occurred, with 0-11 cm as the A1, 11-22/28 as the A2, 22/28-32/39 as the Bh, and 32/39-50/55 as a weak Bs. The sandy material from 50/55 to 136/150 cm appears to be unaffected by podzolization. The upper metre consists almost entirely of quartzose sand. The ability of vegetation and even limited organic matter to sequester Ca in the surface horizon is quite noticeable. The Ca may be of atmospheric origin, as pine foliage has been shown to be efficient at gathering aerosolic nutrients.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-11	9816	7	33	44	10	5	1	0	4.7	3.5	0.04	0.2	0.03	0.46	15	2	–	1.45
11-22	9817	6	31	47	10	5	1	0	4.9	4.7	0.03	0.1	0.01	0.07	7	1	–	1.56
26-36	9818	7	28	48	11	4	2	0	4.9	4.5	0.03	0.1	0.01	0.03	~ 3	1	–	1.56
90-110	9819	8	29	46	11	5	1	0	5.1	4.9	0.03	0.1	0.00	Tr	–	1	–	1.61
150-170	9820	7	21	24	4	3	3	38	4.5	3.9	0.03	1.6	0.03	0.14	5	1	–	1.13

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-11	9816	0.0	0.0	0.1	1.1	0.1	1.2	2.1	57	20	50	50	500	<5	20	<5	–
11-22	9817	0.0	0.0	0.0	0.2	0.0	0.2	0.3	67	10	50	<25	150	<5	10	<5	–
26-36	9818	0.0	0.0	0.0	0.1	0.0	0.1	0.5	20	20	50	<25	50	<5	10	<5	–
90-110	9819	0.0	0.1	0.0	0.2	0.1	0.3	0.2	100	10	50	<25	<25	<5	10	<5	–
150-170	9820	0.1	0.0	0.6	0.0	3.4	0.7	5.7	12	150	1,150	650	<25	10	20	10	–

Soil Classification	Suite Altun Ha	Subsuite Jobo
Soil correlation	FAO/UNESCO Skeletal Eutric Cambisol	USDA Soil Taxonomy Skeletal Eutropeptic Hapludalf
Described:	19.3.90	
Location:	6.5 km north of Sand Hill junction on Old Northern Highway (16Q CQ 571 571)	
Landform:	½ degree slope in flat plain in Jobo Plain land system	
Parent Material:	Doubloon Bank Group siliceous limestone	
Vegetation:	Old secondary regrowth with abandoned coconuts in medium-height broadleaf bush, including large gombolimbo	
Site Drainage:	Good	
Surface:	2-3 cm continuous reddish brown well-humified leaf litter; common coarse flints	

Sample no.	Depth (cm)	
0Z 55/1	0-11	7.5YR 4/2 (brown-dark brown); very fine sandy-silty clay; moderate medium subangular blocky, with rare weak discontinuous clayskins; common coarse and medium pores; moist and slightly firm; many medium and fine roots; common flint stones; clear regular boundary to:
0Z 55/2	11-32	5YR 5/4 (reddish brown); fine sandy clay-clay; moderate medium breaking to fine angular blocky, with weak discontinuous clayskins; common medium pores; moist and firm; common medium and fine roots; rare subrounded siliceous limestone and flint stones; common round slightly hard black ferrimanganiferous concretions; clear slightly wavy boundary to:
	32-55	7.5YR 6/6 (reddish yellow) with many fine faint yellow and yellowish red mottles; bouldery stony clay; stone-dominated structure with interstitial weak medium angular blocky with moderate discontinuous clayskins, especially against stones; common fine pores; stony consistence with interstitial moist and firm; few medium and fine roots; abundant siliceous limestone boulders up to 40 cm across; few black ferrimanganiferous concretions; clear slightly wavy boundary to:
0Z 55/3	55-90+	10YR 7/6 (yellow), with common fine faint pale brown mottles; stony gritty clay-weathering limestone (sascab); moderate fine angular blocky; few medium pores; moist and slightly friable; few medium roots; common slightly hard limestone boulders up to 25 cm across and many limestone grit; few black ferrimanganiferous concretions.

Samples sent to Central Farm.

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Soil Classification	Suite Altun Ha	Subsuite Jobo
Soil correlation	FAO/UNESCO Eutric Cambisol	USDA Soil Taxonomy Eutropeptic Hapudalf
Described:	19.3.90	
Location:	8 km north of Sand Hill junction on Old Northern Highway (16Q CQ 578 586)	
Landform:	2 degrees rectilinear midslope down to rare creek in flat plain in Jobo Plain land system	
Parent Material:	Doubloon Bank Group siliceous limestone	
Vegetation:	Young secondary regrowth on possible old pasture. Wild crabboo, gombolimbo, white chechem, and several abandoned cashew, with fairly dense grass cover	
Site Drainage:	Good	
Surface:	1-2 cm discontinuous grass and leaf litter	

Sample no.	Depth (cm)	
0Z 56/1	0-12	7.5YR 3/2 (dark brown); fine sandy clay loam; weak medium breaking to fine subangular blocky, with very weak discontinuous clayskins; common medium pores; moist and friable; common medium and fine roots; worms; clear regular boundary to:
	12-27	7.5YR 5/2 (brown) with many fine faint reddish brown mottles; fine sandy clay; moderate fine subangular blocky with very weak discontinuous clayskins; few fine pores; moist and slightly firm; few medium and fine roots; clear regular boundary to:
OZ 56/2	27-43	10YR 6/2 (grey-light grey) with many fine distinct reddish yellow and reddish brown mottles; clay; moderate fine-medium angular blocky, with weak discontinuous clayskins; common fine pores; moist and slightly firm; few fine roots; clear regular boundary to:
OZ 56/3	43-55	2.5YR 7/2 (light grey) with many medium distinct reddish yellow and reddish brown and faint yellow mottles; fine sandy clay; moderate medium angular blocky, with weak discontinuous clayskins; few fine pores, moist and slightly firm; few fine roots; common black soft ferrimanganiferous stains; gradual regular boundary to:
OZ 56/4	55-100	Mixed medium-coarse patches of white and dark grey, with many medium distinct yellow and reddish yellow mottles; the white patches are weathering limestone (sascab) of silty clay texture, the dark grey patches are clay; weak coarse-medium angular blocky, with moderate but very patchy clayskins; few medium and coarse pores; moist-dry and friable; rare fine roots; few slightly harder white limestone nodules; diffuse boundary to:
	100-130+	Mixed white and grey, with many medium distinct yellow and reddish yellow mottles; weathering limestone (sascab) of silty clay loam texture; weak coarse-medium angular blocky; few coarse pores; dry-moist and friable.

Samples sent to Central Farm.

Soil Classification	Suite Altun Ha	Subsuite Jobo
Soil correlation	FAO/UNESCO Haplic (Gleyic) Luvisol	USDA Soil Taxonomy Tropaqueptic Rendoll

Described: 20.3.90

Location: 1.5 km from Old Northern Highway on Estevez area of British American Cattle Co. (16Q CQ 551 811)

Landform: Flat low area in flat plain in Jobo Plain land system

Parent Material: Doubloon Bank Group limestone

Vegetation: Low bush but includes small mahogany, sapote, gombolimbo as well as many varied palms, including botan, and palmetto

Site Drainage: Slightly impeded

Surface: 1-2 cm continuous leaf litter; very slight hogwallow microrelief in places

Sample no.	Depth (cm)	
OZ 57/1	0-4	5YR 2.5/1 (black); silty clay loam; moderate fine crumb; abundant medium and fine pores; moist and friable; abundant fine, medium and coarse roots; common patches of white hyphae; worms; clear regular boundary to:
OZ 57/1 (cont.)	4-12	7.5YR 5/2 (brown) with common medium and faint grey patches; very fine sandy clay; weak medium angular blocky; few medium and fine pores; moist, firm, slightly plastic, non-sticky; many medium palm and many fine roots; clear regular boundary to:
OZ 57/2	12-74	5Y 7/1 (light grey) with few fine very faint reddish yellow mottles; silty clay-clay; weak coarse breaking to moderate medium subangular blocky with strong patchy clayskins; few fine pores; moist, firm slightly plastic and very slightly sticky; common medium palm and many fine roots; rare medium flint and few fine soft patches of limestone; this horizon has an inclusion, down an old palm root hole, of 10YR 5/1 (grey); clay; moderate medium angular blocky with moderate continuous clayskins; few fine pores; moist and firm; common medium and many fine roots, diffuse boundary to:
OZ 57/3	74-108	5YR 8/4 (pale yellow) with common fine faint reddish yellow mottles; clay; moderate coarse angular blocky-prismatic breaking to moderate medium angular blocky, with strong continuous clayskins; few fine and medium pores; moist and firm, plastic, slightly sticky; common fine palm roots; rare flint stones; clear regular boundary to:
OZ 57/4	108-130	10YR 8/4 (very pale brown) with common medium faint yellow and reddish yellow mottles; bouldery slightly gritty clay; massive breaking to weak medium angular blocky; few medium and fine pores; moist-dry, friable; rare fine roots; common flint boulders up to 40 cm across, much round slightly hard and soft limestone; common coarse soft black ferrimanganiferous stains.
	130+	Soft white moist weathering limestone (sascab).

Note: This profile was chosen as representative of the lower slope soils in the Jobo Subsuite, more or less equivalent to Pucte. The flints in the third horizon (12-74 cm) were identified as artificial flakes by the Texas A & M team. This suggests that the rate of slopewash in this and surrounding soils may have been very rapid at the time of extensive Maya deforestation.

Samples sent to Central Farm.

Soil Classification	Suite Altun Ha	Subsuite Jobo
Soil correlation	FAO/UNESCO Rendzic Leptosol	USDA Soil Taxonomy Skeletal Lithic Eutropept

Described:	20.3.90
Location:	Estevez area of British American Cattle Co. (16Q CQ 514 786)
Landform:	Slight (1 degree) lower slope in Jobo Plain land system
Parent Material:	Doubloon Bank Group flinty siliceous limestone
Vegetation:	Logged high bush with santa maria, gombolimbo, sapote.
Site Drainage:	Good
Surface:	Common clumps of coarse flints, up to 40 cm across. 1-3 cm continuous leaf litter. Slight microrelief due to old treefall

Sample no.	Depth (cm)	
0Z 58/1	0-10	7.5YR 3/2 (dark brown); fine sandy clay loam-fine sandy clay; moderate medium-coarse breaking to fine subangular blocky, with weak discontinuous pressure faces against stones; abundant fine and medium roots; moist and slightly firm; abundant fine and many coarse and medium roots; few medium flints; worms, ants and larvae; common patches of white hyphae; clear slightly wavy boundary to:
	10-26	7.5YR 3/4 (dark brown); extremely stony fine sandy clay; structure dominated by stones, with moderate medium angular blocky in interstitial fine earth, with weak discontinuous clayskins, mainly against stones; many medium and coarse pores; stony consistence with fine earth moist and slightly firm, very slightly plastic, non-sticky; many medium and coarse roots; abundant angular and rounded flints up to 40 cm across; gradual regular boundary to:
	26-39/44	10YR 5/4 (yellowish brown) with common fine faint reddish yellow and yellow mottles; extremely stony fine sandy clay; stone-dominated structure with interstitial moderate fine angular blocky, with weak discontinuous clayskins; common medium and fine pores; consistence as in above horizon; common medium and fine roots; abundant flints up to 25 cm across; few hard round black ferrimanganiferous concretions; clear slightly wavy boundary to:
	39/44 – 48/52	7.5YR 4/2 (brown-dark brown) very gritty clay loam; moderate fine crumb, many medium and fine pores; moist and slightly friable; many fine roots; few flint stones up to 10 cm across and common flint grit; clear slightly wavy boundary to:
	48/52 – 70+	7.5YR 8/4 (pink) dry crumbly weathering limestone (sascab) with harder limestone cores; becoming generally harder with depth; common fine roots decreasing to rare.

Note: This is a very stony example of shallow medium-textured Jobo. Note the slightly reddish hues, indicating good drainage. Although difficult to auger and dig, the dense flint stone line is apparently no barrier to deep root penetration.

Sample sent to Central Farm.

Soil Classification	Suite Puletan	Subsuite Crooked Tree
Soil correlation	FAO/UNESCO Humic Podzol	USDA Soil Taxonomy Tropohumod

Described: 21.3.90

Location: Revenge Lagoon back road, close to main quarry (16Q CQ 357 738)

Landform: Flat area in gently undulating plain in Crooked Tree Plain land system

Parent Material: Deep Pleistocene siliceous alluvium

Vegetation: High stature and high density Pine Ridge with large oaks, moderate pines, common large-medium profusely flowering wilding cashew, scattered palmetto and crabboo. Sparse grass cover

Site Drainage: Good

Surface: Some bare white surface, with 1 cm discontinuous dry leaf litter

Sample no.	Depth (cm)	
0Z 59/1	0-9	10YR 7/1 (light grey); fine-medium sand; single grain; moist and loose; common-few fine and medium roots; gradual regular boundary to:
OZ 59/2	9-48	10YR 8/1 (white); fine sand; single grain; moist and very loose; few fine and medium roots; abrupt slightly wavy boundary to:
OZ 59/3	48-62	7.5YR 5/6 (strong brown) with common coarse distinct brown and yellowish brown patches; fine sand; weak medium angular blocky breaking to single grain; few medium pores; moist and slightly fragic; rare medium roots; diffuse boundary to:
OZ 59/4	62-100	10YR 6/6 (brownish yellow) with many medium faint brown and yellow and few fine faint reddish yellow mottles, all decreasing with depth; fine sand; very weak coarse angular blocky easily breaking to single grain; few fine pores; moist and friable; rare fine roots; gradual regular boundary to:
	100-120	10YR 7/2 (light grey), with abundant medium and coarse prominent bright red, yellow and brown mottles; loamy medium sand; weak coarse angular blocky breaking to single grain; many medium and fine pores; moist, slightly friable; rare medium pine roots; diffuse boundary to:
OZ 59/5	120-140+	Brightly variegated white, red, yellow and brown; medium sandy clay loam; weak coarse angular blocky; moderate discontinuous clayskins; common medium and coarse pores; moist and firm with few patches slightly indurated; few fine roots; common rounded quartz grit.

Samples sent to Central Farm.

Soil Classification		Suite Revenge	Subsuite Tok
Soil correlation		FAO/UNESCO Eutric Planosol	USDA Soil Taxonomy Albaqualf
Described:		21.3.90	
Location:		1 km west of New Northern Highway, Revenge Lagoon development area (16Q CQ 403 748)	
Landform:		Flat area in flat plain in Tok Plain land system	
Parent Material:		Siliceous drift over Doubloon Bank Group limestone	
Vegetation:		Open Pine Ridge with very scattered small pines (*Pinus caribaea*) and palmetto. Tussocky grasses	
Site Drainage:		Imperfect	
Surface:		1 cm very discontinuous grass litter	

Sample no.	Depth (cm)	
OZ 60/1	0-11	10YR 4/2 (dark greyish brown); loamy medium sand; weak medium crumb breaking easily to single grain; moist and very friable, almost loose; many ants; diffuse boundary to:
	11-20	10YR 7/3 (very pale brown) with many very fine, very faint grey and reddish brown mottles; loamy medium sand; weak medium subangular blocky breaking to single grain; common medium pores; moist and friable; common medium roots; gradual regular boundary to:
OZ 60/2	20-38	Distinct mixture of 10YR 6/8 (brownish yellow) and 10YR 7/1 (light grey); medium sandy clay loam; massive; many medium and coarse pores; moist-wet, extremely plastic and extremely sticky; rare medium and fine roots; diffuse boundary to:
OZ 60/3	38-120	2.5YR 8/2 (white) with many medium distinct reddish and brownish yellow mottles; medium sandy clay loam; massive with occasional weak cleavage plane, with very weak and very discontinuous clayskins; moist-wet, very plastic and very sticky; rare fine roots and one vertical medium pine root; diffuse boundary to:
OZ 60/4	120-150	5Y 8/1 (white) with few coarse distinct reddish reddish and brownish yellow mottles; medium sandy clay loam; massive breaking to weak medium angular blocky, with weak continuous clayskins; common medium pores; moist-wet, firm, slightly plastic and slightly sticky; very rare fine roots; common fine-medium tubular and polyhedral gypsum crystals clustered in nests; many prominent soft black manganiferous stains; gradual regular boundary to:
	150-160+	White, with common medium distinct yellow mottles; gritty sandy clay loam; moderate medium angular blocky; wet, slightly plastic and slightly sticky; common subrounded quartz grit, limestone fragments and coarse gypsum crystals.

Note: The topsoil in this profile is not as acid and decalcified as that in the other example of Tok Subsuite, OZ 21. The subsoil is remarkable for its extremely sticky consistence.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Soluble cations me/100 g Na	Soluble cations K	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-11	9821	1	15	45	20	12	3	4	7.1	7.1	0.33	–	–	0.7	0.06	0.52	9	2	0	1.32
20-38	9822	9	14	20	9	6	4	38	7.1	6.8	0.90	0.1	0.0	4.4	0.02	0.09	5	3	0	1.14
60-80	9823	3	12	24	12	7	7	35	7.9	7.5	0.43	–	–	4.4	0.01	0.02	~2	3	0	1.28
120-150	9824	3	14	31	12	6	5	29	7.3	7.1	1.65	0.0	0.0	4.3	0.01	0.04	~4	3	0	1.26

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-11	9821	0.2	0.0	0.6	4.6	–	5.4	4.2	100	20	100	400	1,200	10	20	<5	–
20-38	9822	0.3	0.1	1.7	21.0	–	23.1	19.3	100	40	850	2,200	4,700	10	40	30	–
60-80	9823	0.2	0.1	1.7	25.1	–	27.1	19.1	100	50	800	2,350	5,850	10	90	30	0.5
120-150	9824	0.2	0.1	1.8	29.9	–	32.0	18.4	100	30	1,200	2,850	6,750	10	1,460	20	–

Profile 0Z 61

Soil Classification	Suite Melinda	Subsuite Quamina
Soil correlation	FAO/UNESCO Dystric Fluvisol	USDA Soil Taxonomy Dystric Tropofluvent
Described:	4.4.90	
Location:	Caribbean Investments Ltd pasture, north of Hummingbird Highway, Caves Branch (16Q CP 195 975)	
Landform:	Upper convex 1 degree slope of terrace in Cayo Floodplains land system	
Parent Material:	Old riverine alluvium	
Vegetation:	Long-established pasture. Native grasses, with few cohunes	
Site Drainage:	Good	
Surface:	Very slight old hogwallow. Compact and grey-looking worm casts	

Sample no.	Depth (cm)	
0Z 61/1	0-14	10YR 6/3 (pale brown) with common fine distinct reddish brown and reddish mottles; silty loam; moderate fine subangular blocky and some worm casts; common coarse pores; moist-dry, slightly friable; many fine roots; earthworms; clear regular boundary to:
OZ 61/2	14-23	10YR 7/6 (yellow) with many medium faint reddish yellow and pale yellow mottles; silty loam; moderate medium angular blocky; rare clayskins lining root channels; common medium pores; moist-dry, slightly firm-hard; common medium roots; gradual slightly wavy boundary to:
OZ 61/3	23-75	7.5YR 7/6 (reddish yellow) with medium distinct red mottles that decrease from many to common with depth; silty clay moderate medium angular blocky with moderate discontinuous clayskins and pressure faces; no pores visible; moist, compact, fragic (crumbles readily in hand); few medium and fine roots; rare fine black ferrimanganiferous concretions; occasional old tree root channel infilled with brown friable silty clay; diffuse boundary to:
OZ 61/4	75-135	Distinctly variegated coarse patchwork of 2.5YR 5/6 (red), 7.5YR 7/8 (reddish yellow) and 10YR 7/8 (yellow); silty clay loam; moderate-weak medium angular blocky, with common strong pressure faces; moist, compact and fragic; rare fine and medium pores; very rare fine roots but few traces of old cohune root; rare fine black ferramanganiferous concretions.
Continued by auger:		
	135-225+	As above

Note: The slight compaction of the surface is due to grazing animals rather than raindrop capping, but indicates the structural vulnerability of topsoils with high silt contents. The fragic subsoil compaction occurs in many fine-textured old alluvial soils.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-14	9825	1	5	11	11	23	31	18	4.8	4.1	0.05	1.3	0.14	1.38	10	4	–	1.04
14-23	9826	2	4	9	10	19	32	24	4.5	3.8	0.04	1.1	0.08	0.49	6	2	–	1.11
30-50	9827	0	1	2	3	7	30	57	4.3	3.8	0.03	1.8	0.09	0.19	~ 2	1	–	0.98
90-110	9828	0	0	2	4	10	39	45	4.4	3.8	0.03	1.5	0.09	0.15	~ 2	1	–	1.05

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-14	9825	0.0	0.1	0.3	0.6	1.2	1.0	5.4	19	120	6,550	750	250	10	80	10	–
14-23	9826	0.0	0.0	0.2	0.0	1.9	0.2	4.8	4	90	8,950	950	100	<5	50	20	–
30-50	9827	0.0	0.0	0.2	0.0	5.2	0.2	7.8	3	100	20,400	2,050	<25	20	40	40	–
90-110	9828	0.0	0.0	0.1	0.0	5.5	0.1	6.9	1	140	20,000	1,900	<25	30	80	50	–

Soil Classification	Suite Melinda	Subsuite Quamina-Canquin
Soil correlation	FAO/UNESCO Eutric Fluvisol	USDA Soil Taxonomy Eutric Tropofluvent

Described: 4.4.90

Location: Caribbean Investments Ltd cacao block, south of Hummingbird Highway, Caves Branch (16Q CP 181 951)

Landform: Flat calcareous terrace subunit of Caves Branch in Cayo Floodplains land system

Parent Material: Moderately old riverine alluvium, mostly from Santa Rosa Group metasedimentary rocks

Vegetation: Low secondary bush

Site Drainage: Good

Surface: 1 – 2 cm dry leaf and twig litter

Sample no.	Depth (cm)	
OZ 62/1	0-12	5YR 4/4 (reddish brown); silty clay loam; moderate fine subangular blocky; many fine pores; moist-dry and friable; many medium and fine roots; earthworms; gradual regular boundary to:
OZ 62/2	12-26	5YR 4/6 (yellowish red); silty clay loam; moderate medium angular blocky, with rare weak clayskins; common medium pores; moist and friable; common medium roots; rare fine rounded red sandstone pebbles; few worms; clear regular boundary to:
	26-34	Stone line of rounded and subrounded quartzite and calcite pebbles up to 7 cm across, set in material as above horizon; clear regular boundary to:
OZ 62/3	34-62	5YR 4/6 (yellowish red); silty clay loam; weak coarse breaking to moderate fine subangular blocky with moderate discontinuous clayskins; common fine pores and common coarse small mammal burrows; moist and friable; common fine roots; rare fine soft black ferrimanganiferous concretions; diffuse boundary to:
OZ 62/4	62-150+	5YR 5/8 (yellowish red), silty clay; weak coarse breaking to moderate fine subangular blocky with weak discontinuous clayskins; common medium pores; moist and friable (with occasional patches of firm consistence); few fine roots decreasing to very rare at depth.

Note: This is typical of the deep and friable soils found on all but the highest terrace remnants in the Caves Branch basin. It is less leached and acidified than the older soil on the terrace, Profile OZ 61. The high silt content is mainly micaceous and gives the high total K contents.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-12	9829	1	1	2	5	19	41	31	5.6	5.2	0.08	2.4	0.32	2.50	8	3	0	0.97
12-26	9830	1	1	2	4	18	40	34	5.7	5.1	0.05	1.9	0.18	1.01	6	2	0	1.04
34-62	9831	0	1	1	6	18	40	34	7.4	6.7	0.06	1.8	0.10	0.53	5	2	0	1.10
90-110	9832	0	1	0	2	13	44	40	7.0	6.5	0.05	1.4	0.08	0.11	−1	2	0	1.07

		Exchangeable cations me/100 g a.d.s.								Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-12	9829	0.0	0.2	1.6	9.7	–	11.5	13.9	83	470	15,700	1,800	2,200	30	1,090	60	–
12-26	9830	0.0	0.1	0.9	5.9	–	6.9	9.4	73	430	17,600	1,950	1,450	30	1,140	70	–
34-62	9831	0.0	0.0	0.2	9.9	–	10.1	9.6	100	270	17,300	1,850	2,250	30	1,160	50	–
90-110	9832	0.0	0.1	0.1	4.9	–	5.1	6.0	85	220	23,100	1,900	1,250	40	1,270	70	–

Soil Classification	Suite Melinda	Subsuite Quamina
Soil correlation	FAO/UNESCO Eutric Fluvisol	USDA Soil Taxonomy Eutric Tropofluvent

Described:	5.4.90
Location:	0.6 km north of Hummingbird Highway at Over-the-Top (16Q CP 283 904)
Landform:	1 degree rectilinear midslope of high floodplain bench in Cayo Floodplains land system
Parent Material:	Riverine alluvium from Santa Rosa Group metasediments, possibly with calcareous inputs from flanking hills of Cretaceous limestone
Vegetation:	Well-pruned and cleared young Valencia oranges. Thick grass cover recently bush-hogged
Site Drainage:	Good
Surface:	0-1 cm discontinuous grass litter

Sample no.	Depth (cm)	
0Z 63/1	0-16	7.5YR 4/4 (brown-dark brown); silty loam; moderate medium subangular blocky, tending to break to moderate fine crumb; few medium and coarse pores; moist and slightly friable; many medium and fine roots; rare round quartzite pebble; earthworms; rare charcoal; clear regular boundary to:
OZ 63/2	16-32	5YR 5/6 (yellowish red); silty loam; weak coarse angular blocky breaking to moderate fine crumb, with rare weak clayskins on root channel walls; abundant pores of all sizes; moist and extremely friable; common medium and fine roots; rare rounded quartzite pebbles; gradual regular boundary to:
OZ 63/3	32-81	5YR 5/6 (yellowish red); silty clay loam; moderate coarse angular blocky, tending to break to moderate medium crumb; with few clayskins on root channel walls; many pores of all sizes; moist and very friable; common medium and fine roots; rare rounded quartzite pebbles and boulders; few fine slightly hard black ferrimanganiferous concretions; clear slightly wavy boundary to:
	81-100+	5YR 5/8 (yellowish red); extremely stony and bouldery gritty loam; stony-single grain structure; rare fine pores; stony consistence, with interstitial loam very friable; common fine and few coarse tuberous roots; abundant quartzite boulders and stones up to 30 cm across, with a few metaargillitics.

Note: This is typical of the alluvial soils of the St Margaret's-Dry Creek Valley in having a prominent stony-bouldery layer. The depth of stone-free soil (81 cm) is high for the area. A feature of this soil is the friability.

Samples sent to Central Farm.

Soil Classification	Suite Chacalte	Subsuite Xpicilha
Soil correlation	FAO/UNESCO Vertic Cambisol	USDA Soil Taxonomy Vertic Eutropept

Described:	6.4.90
Location:	0.5 km south of Hummingbird Highway, Ringtail Village (16Q CP 217 976)
Landform:	Slightly elevated flat area in undulating plain in Xpicilha Hills with Plains land system. Close to intermittent drainage line
Parent Material:	Hillwash from Cretaceous limestone
Vegetation:	Remnant of high cohune ridge in area developed for smallholder cacao. Occasional sapote
Site Drainage:	Good
Surface:	3-5 cm of dry leaf litter, with rare limestone fragment, up to 10 cm across

Sample no.	Depth (cm)	
0Z 64/1	0-14	10YR 3/1 (very dark grey); clay; strong-moderate medium subangular blocky breaking to moderate medium crumb; few medium and coarse pores; moist and slightly firm-friable; common coarse and medium roots; gradual regular boundary to:
OZ 64/2 (+ Kubiena tin)	14-38	10YR 2/1 (black); clay; strong medium subangular blocky, with weak discontinuous clayskins; common coarse and medium pores; moist and firm; common medium roots; clear regular boundary to:
OZ 64/3 (+ Kubiena tin)	38-64/74	2.5Y 4/4 (olive brown); clay; moderate coarse breaking to moderate fine angular blocky, with strong continuous clayskins, pressure faces and moisture films (virtually no trace of slickenside striations); rare fine and medium pores; moist and friable; few medium and fine roots; clear wavy boundary to:
	64/74-93	2.5Y 5/2 (greyish brown), with many medium faint reddish yellow and brown mottles; sandy concretionary clay; weak medium angular blocky, with moderate continuous clayskins, pressure faces and moisture films; moist and friable; few fine roots; rare rounded fragments of hard limestone; many fine round hard black ferrimanganiferous concretions; clear regular boundary to:
	93-102	10YR 6/3 (pale brown), with many fine faint brown mottles; extremely gritty clay loam; weak medium angular blocky breaking to single grain; moist and friable; few fine roots; few hard rounded fragments of siliceous limestone; abundant medium and coarse hard round black ferrimanganiferous concretions; clear regular boundary to:
	102-120+	10YR 8/2 (white), with common medium faint reddish yellow and brown mottles; stony silty loam; weak fine angular blocky with few weak clayskins; few fine pores; moist and friable; few medium and fine roots; common hard siliceous limestone stones and boulders, up to 80 cm across; few black ferrimanganiferous concretions; calcareous.

Note: A prominent feature of this profile is the abundance of ferrimanganiferous concretions in the subsoil just above the limestone wash parent material.

Samples sent to Central Farm.

Soil Classification	Suite Guinea Grass	Subsuite Pixoy
Soil correlation	FAO/UNESCO Eutric Planosol	USDA Soil Taxonomy Haplaqualf
Described:	10.4.90	
Location:	4 km south of Carmelita (16Q CQ 359 885)	
Landform:	1 degree midslope on undulating plain in Lazaro Plain land system	
Parent Material:	Siliceous drift over Tower Hill Formation limestone	
Vegetation:	Poor maize with many grass weeds	
Site Drainage:	Good	
Surface:	Virtually bare, with only few maize stovers	

Sample no.	Depth (cm)	
0Z 65/1	0-11	N3/. (very dark grey) moist , N5/. (grey) dry; loamy fine sand; weak fine crumb breaking to single grain; common medium and fine pores; moist-dry, very friable-loose; many fine roots; no worms; gradual regular boundary to:
	11-29	10YR 5/1 (very dark grey) moist, 10YR 5/1 (grey) dry; fine sand- loamy fine sand; weak medium subangular blocky, easily crumbling to single grain; moist and very friable; common fine and medium roots; diffuse boundary to:
	29-40	10YR 7/3 (very pale brown) moist, 10YR 7/2 (light grey) dry; fine sand-loamy fine sand; weak medium subangular blocky easily breaking to single grain; moist and very friable; few medium and fine roots; abrupt regular boundary to:
OZ 65/2	40-63	10YR 5/4 (yellowish brown) with many medium distinct yellowish red, reddish yellow and pale brown mottles; medium sandy clay loam; strong coarse subangular blocky, with strong discontinuous clayskins and very dark grey humus coatings; common coarse pores; moist and very firm, slightly compact; common fine roots; clear vertical old tree root channel infilled with very dark grey sandy loam-loamy sand; diffuse boundary to:
OZ 65/3	63-135/150	10YR 7/2 (light grey) with medium distinct red mottles decreasing from few to rare with depth; coarse sandy clay-sandy clay loam; moderate coarse prismatic breaking to moderate medium angular blocky with weak discontinuous clayskins; common fine pores; moist and firm; rare fine roots, but old infilled root channels continue from above horizon; clear wavy boundary to:
	135/150-140/155	Discontinuous layer of black soft ferrimanganiferous stains and dark brown organic matter set in 2.5Y 7/2 (light grey) sandy clay; massive; moist and slightly plastic and slightly sticky.
	140/155-170+	Light grey – pale yellow soft-slightly hard weathering limestone (sascab) with harder nodules; grades horizontally into sandy clay with common dark brown organic stains.

Note: The organic matter as well as the clay appears to be moving downwards. This and the strong textural contrast puts this profile towards Felipe Subsuite. The organic layer at 135-140/150-155 may be due to mobile organic matter, or it may be traces of old mangrove deposits atop the limestone prior to the deposition of the siliceous drift.

Samples sent to Central Farm.

Soil Classification	Suite Yaxa	Subsuite Jolja
Soil correlation	FAO/UNESCO Skeletal Eutric Cambisol	USDA Soil Taxonomy Skeletal Eutropept

Described: 11.4.90

Location: 2.9 km west of Blue Creek-Gallon Jug road, on track into La Milpa archaeological site (16Q BQ 831 730)

Landform: 2 degrees upper slope in area of gently rolling plain in Neustadt Plain land system

Parent Material: Barton Creek Formation limestone, with some flints

Vegetation: Logged high forest

Site Drainage: Good

Surface: 2-3 cm continuous leaf litter. Rare flint stones

Sample no.	Depth (cm)	
0Z 66/1	0-9	10YR 3/2 (very dark greyish brown); clay; strong medium subangular blocky; few medium pores; moist and firm; abundant medium and coarse roots; common worms; clear regular boundary to:
OZ 66/2	9-38	10YR 3/1 (very dark grey); clay; strong medium-coarse subangular blocky; few coarse pores; moist and firm; many medium and fine roots; few fine white slightly hard limestone grit; worms; clear slightly wavy boundary to:
	38-45	Stone line of flints and jaspers set in 10YR 4/1 (dark grey); clay; strong medium subangular blocky; moist and firm; clear slightly wavy boundary to:
	45-51	10YR 4/1 (dark grey); clay; moderate medium angular blocky, with weak discontinuous clayskins; few coarse pores; moist and slightly firm; common medium and fine roots; common medium slightly off white-cream weathering limestone (sascab); worms; clear slightly wavy boundary to:
	51-80+	Pinkish-white soft weathering limestone with harder nodules; common medium and fine roots; clear vertical tapering infilling of old tree root channel with brownish grey mixed clay and weathering limestone.

Note: This profile shows the strong blocky structures in the surface horizons of limestone soils under forest in this part of Belize. Note that the siliceous stone line does not occur at the interface between the solum and the underlying limestone.

Samples sent to Central Farm.

Soil Classification	Suite Yaxa	Subsuite Ramgoat
Soil correlation	FAO/UNESCO Chromic Luvisol	USDA Soil Taxonomy Rhodudalf
Described:	13.4.90	
Location:	Rancho Dolores-Hill Bank Road (16Q CQ 133 388)	
Landform:	Flat, slightly elevated plain in Hill Bank Plain land system	
Parent Material:	Cayo Group limestone	
Vegetation:	Logged high Cohune Ridge forest with cohune, sapote, cottonwood and ironwood	
Site Drainage:	Good	
Surface:	2-3 cm leaf litter, with some patches of white hyphae	

Sample no.	Depth (cm)	
0Z 67/1	0-18	7.5 YR 3/2 (dark brown); clay; moderate medium subangular blocky breaking to moderate medium crumb, with common moisture films; common medium and coarse pores; moist and friable; abundant fine and medium roots; few medium hard black ferrimanganiferous concretions; many worms; gradual regular boundary to:
	18-33	7.5 4/2 (brown-dark brown); clay; structure, pores, and consistence as in surface horizon; roots decrease to many; worms less frequent; no concretions seen; clear regular boundary to:
	33-51	7.5YR 5/4 (brown); clay; weak medium angular blocky, breaking to moderate medium crumb, weak discontinuous moisture films and clayskins; common medium pores; moist and friable; few fine roots; many hard-slightly hard round black ferrimanganiferous concretions; gradual regular boundary to:
OZ 67/2	51-96	7.5YR 6/8 (reddish yellow), with common distinct red mottles, slightly gravelly clay; weak medium subangular blocky, with weak discontinuous clayskins against gravel; few medium pores; moist and compact breaking to friable in hand (fragic); rare fine roots; gravel is abundant hard black ferrimanganiferous concretions; clear slightly wavy boundary to:
	96-110+	Large subrounded boulders of hard white crystalline limestone; with interstitial 7.5YR 4/4 (brown-dark brown) clay; weak medium crumb, with moderate clayskins against stones; few medium pores; moist and firm; common fine roots, especially concentrated as mats coating boulders.

Note: This profile shows clear characteristics of Ramgoat soils, but lacks the reddish topsoil colours and the extreme fragic compaction in the subsoil. The limestone does not appear to be *in situ*, but further excavation was precluded by lack of time. The abundancy concretionary gravel is parallelled by the high total Mn levels, especially in the subsoil.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-18	9833	19	2	3	1	4	12	59	6.1	5.6	0.11	5.8	0.49	3.80	8	3	–	1.04
60-80	9834	42	2	1	0	1	3	51	6.1	5.8	0.04	3.9	0.04	0.14	~4	2	–	1.21

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-8	9833	0.1	0.1	2.2	18.7	–	21.1	26.0	81	360	700	1,750	4,300	80	3,300	140	–
60-80	9834	0.0	0.1	0.6	6.4	–	7.1	9.5	75	250	500	1,550	1,350	90	12,830	180	–

Soil Classification	Suite Yaxa	Subsuite Chacluum
Soil correlation	FAO/UNESCO Chromic Eutric Cambisol	USDA Soil Taxonomy Eutropept

Described: 17.4.90

Location: Yalbac-Hill Bank Road, 0.9 km north of Ramgoat Creek junction (16Q CQ 125 369)

Landform: Flat area on undulating plateau with occasional low limestone hills in Hill Bank Plain land system

Parent Material: Cayo Group limestone

Vegetation: Logged high cohune ridge with high proportion of cohune, sapote and tabroos

Site Drainage: Good

Surface: 2 cm continuous leaf litter

Sample no.	Depth (cm)	
0Z 68/1	0-5	5YR 4/3 (reddish brown); clay; moderate medium subangular blocky breaking to moderate medium crumb; few fine pores; moist and slightly friable; abundant roots of all sizes; few white hyphae; gradual regular boundary to:
OZ 68/1 (cont.)	5-21	5YR 4/4 (reddish brown); clay; moderate fine subangular blocky, with weak discontinuous clayskins; common medium and fine pores; moist and slightly firm; common roots of all sizes, including very coarse; few fine round hard black ferrimanganiferous concretions; diffuse boundary to:
OZ 68/2	21-46/54	5YR 4/6 (yellowish red); clay; weak medium angular blocky crumbling readily to weak fine crumb; weak discontinuous clayskins and moisture films; common medium and fine pores; moist and firm, slightly sticky; common medium and fine roots; many fine round hard black concretions; clear slightly wavy boundary to:
	46/54-80+	Pink-brown-cream soft weathering limestone with common hard patches of white crystalline limestone, these predominant by 70 cm; common medium and fine roots in softer patches.

Note: Although rudimentary and shallow, this profile already shows the tendency for the soils of Chacluum to develop towards Ramgoat, with increasingly yellowish, compact and concretionary subsoils.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-10	9835	8	3	3	3	5	11	67	6.6	6.3	0.19	7.5	0.63	5.53	9	2	–	0.84
21-45	9836	9	1	1	1	1	4	83	6.4	5.7	0.06	6.9	0.17	0.98	6	2	–	1.09

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-10	9835	0.0	0.3	3.0	34.5	–	37.8	36.5	100	300	800	2,700	7,650	40	1,950	110	–
21-45	9836	0.0	0.2	1.1	22.5	–	23.8	25.4	94	170	900	2,950	4,650	50	1,080	120	–

Soil Classification	Suite Yaxa	Subsuite Irish Creek
Soil correlation	FAO/UNESCO Gleyic Luvisol	USDA Soil Taxonomy Haplaqualf
Described:	17.4.90	
Location:	2.5 km west of Hill Bank on Gallon Jug Road (16Q CQ 176 460)	
Landform:	Midslope (0.5 degrees gradient) on slight rise in flat plain with occasional low hills in Hill Bank Plain land system	
Parent Material:	Cayo Group limestone	
Vegetation:	Low disturbed forest with many palms – cohune and botan; also frequent red gombolimbo, low pucte	
Site Drainage:	Slightly impeded	
Surface:	1-3 cm of leaf litter. Slight hogwallow microrelief	

Sample no.	Depth (cm)	
0Z 69/1	0-13	10YR 5/3 (brown); fine sandy clay; moderate medium subangular blocky breaking to moderate fine crumb, with weak discontinuous clayskins; common medium and fine pores; moist and friable; many medium and fine roots; few very fine calcite crystals; clear regular boundary to:
OZ 69/2	13-37	10YR 5/4 (yellowish brown) with many fine faint reddish and olive yellow mottles; clay; moderate medium angular blocky, with weak discontinuous clayskins; few medium pores; moist and very firm, common medium palm roots; diffuse boundary to:
OZ 69/3	37-82	10YR 7/2 (light grey), with abundant medium distinct yellowish red and reddish brown mottles; clay; massive breaking to moderate fine angular blocky with moderate continuous clayskins; few fine pores; moist and very firm; few medium palm and few fine roots; diffuse boundary to:
OZ 69/4	82-160	10YR 7/1 (light grey), with common medium prominent dark red and yellowish brown mottles; clay; massive breaking to weak medium angular blocky, with medium continuous clayskins and/or pressure faces; rare fine pores; moist and very firm; rare medium palm roots right down to 160 cm.
Continued by auger:		
	160-180	As above
	180-240	Light grey with many coarse distinct brownish yellow mottles; clay; moist and very firm, soft black ferrimanganiferous strains increase from common to abundant.
	240-250+	Slightly hard – hard pinkish white crystalline limestone.

Note: A prominent feature of this soil is the firm consistence of the whole subsoil. This is not at all fragic, as it persists after the soil is disturbed. It does not preclude root penetration.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-13	9837	5	5	10	10	17	30	23	5.6	5.3	0.10	2.2	0.23	2.34	10	3	–	1.17
13-37	9838	1	1	2	3	4	10	79	4.7	3.7	0.03	4.6	0.07	0.53	8	2	–	1.04
37-82	9839	1	0	3	3	4	6	83	4.6	3.7	0.04	4.6	0.04	0.28	7	2	–	1.13
110-130	9840	1	0	3	3	5	11	77	4.7	3.6	0.04	5.0	0.02	0.12	6	2	–	1.15

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-13	9837	0.0	0.1	1.0	8.1	0.0	9.2	11.7	79	180	150	550	1,800	10	550	50	–
13-37	9838	0.0	0.1	1.2	9.1	4.0	10.4	17.6	59	90	400	1,550	1,550	30	100	80	–
37-82	9839	0.0	0.1	0.4	7.6	7.3	8.1	18.2	45	90	450	1,500	1,350	40	50	80	–
110-130	9840	0.1	0.1	0.1	12.9	4.4	13.2	20.1	66	80	450	1,550	2,350	40	50	100	–

Soil Classification	Suite Yaxa	Subsuite Yalbac
Soil correlation	FAO/UNESCO Eutric Cambisol	USDA Soil Taxonomy Rendoll
Described:	19.4.90	
Location:	About 6 km south of Shipyard on Shipyard-Water Bank track (16Q CQ 251 730)	
Landform:	Flat area on low platform in flat plain in Shipyard Plain land system	
Parent Material:	Cayo Group limestone	
Vegetation:	Old secondary high Cohune Ridge, with many medium-sized cohune	
Site Drainage:	Good	
Surface:	1-2 cm continuous leaf and twig litter	

Sample no.	Depth (cm)	
	0-1	5YR 3/2 (dark reddish brown); fibrous loam; moderate fine subangular blocky bound by roots; common fine pores; moist and slightly friable; abundant fine and medium roots; abundant white hyphae; clear regular boundary to:
OZ 70/1	1-18	7.5YR 2.5/1 (black); clay; strong medium blocky; common fine pores; moist and firm; common roots of all sizes; rare fine subrounded fragments of slightly hard limestone; common patches of white hyphae, especially in top 10 cm; common Mayan potsherds; gradual regular boundary to:
0Z 70/2	18-36/40	N4/. (dark grey); clay; moderate medium angular blocky, with weak discontinuous clayskins and pressure faces; few medium pores; moist and firm; common medium and fine roots; rare fragments of slightly hard limestone; clear slightly wavy boundary to:
	36/40-45	Discontinuous horizon of 10YR 4/2 (dark greyish brown) with darker and lighter patches; gravelly clay; moderate fine angular blocky-gravelly; many fine and medium pores; moist and slightly friable; common medium roots, especially palms; gravel is slightly hard pale brown limestone; also large stones of hard white limestone which occupies whole horizon in places; clear regular boundary to:
	40/45-70	10YR 8/2 (white) slightly hard-soft weathering limestone (sascab) with common corestones of harder, whiter crystalline limestone; common palm roots in sascab.

Note: Although the solum is shallow, this profile shows that sascab is part of the rooting zone, especially for palms.

Samples sent to Central Farm.

Soil Classification	Suite Tintal	Subsuite Chucum
Soil correlation	FAO/UNESCO Gleyic Planosol	USDA Soil Taxonomy Haplic Tropaqualf

Described: 21.4.90

Location: Grassy Piece, across the New River from Shipyard (16Q CQ 312 802)

Landform: Flat area on gently undulating plain in San Felipe Plain land system

Parent Material: Siliceous drift over limestone

Vegetation: Mosaic of open grassy savanna with few palmettoes and pines, and dense clumps of tintal. Pit is on border of clump, with sparse tufts of grass

Site Drainage: Imperfect

Surface: Bare soil between grass tufts

Sample no.	Depth (cm)	
OZ 71/1	0-9	10YR 6/2 (grey-light grey); loamy fine sand; weak fine subangular blocky breaking readily to single grain; few medium pores; moist-dry, very friable-loose; common medium and fine roots; clear regular boundary to:
OZ 71/3	9-37	10YR 4/2 (dark greyish brown), with many fine faint brown and strong brown, and common fine linear distinct reddish brown mottles; coarse sandy clay loam; very strong coarse prismatic, with slightly oblique horizontal faces; thin sandy coatings between peds; common medium pores, often lined reddish brown; moist-dry, extremely firm and compact; common medium roots; common subrounded quartz grit; clear regular boundary to:
OZ 71/3	37-70	2.5YR 7/2 (light grey), with common fine distinct reddish yellow mottles; medium sandy clay loam; moderate medium angular blocky, with very weak discontinuous clayskins; few medium and fine pores; moist and slightly firm; few medium palm roots; occasional coarse patches and common fine flecks of soft white crystalline limestone; abundant gypsum crystals, especially around limestone; common medium soft black ferrimanganiferous stains; diffuse boundary to:
OZ 71/4	70-145	2.5YR 8/2 (white) with many coarse distinct reddish yellow mottles; medium sandy clay; moderate medium angular blocky, with strong continuous clayskins; prominent veins of 10YR 8/3 (very pale brown) loamy coarse sand between peds; common medium pores; moist and firm; very fine roots; common white flecks of soft white limestone; common gypsum crystals; few fine hard round black ferrimanganiferous concretions; diffuse boundary to:
	145-175	10YR 7/1 (light grey), with common very coarse prominent reddish yellow mottles; (medium sandy) clay; moderate medium angular blocky with some oblique horizontal faces; very strong continuous clayskins (almost slickensides); thin pale brown veins of sandy loam; common fine pores; moist and firm; no roots; common fragments of slightly hard white limestone; rare gypsum crystals; many very fine hard round black ferrimanganiferous grit.
Continued by auger		
	175-260+	As above

Note: This profile looks somewhat like a Felipe at the top but the deeper horizons resemble a Tok, although lacking the extremely plastic and sticky consistence of that subsuite. This soil is clearly influenced by brackish groundwater, e.g. subsoil pH, conductivity, soluble Na and exchangeable Na (ESP >20%). The high Ca status is partly due to the presence of gypsum. The presence of ferrimanganiferous concretions is not reflected in the Mn contents.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Soluble cations me/100 g Na	Soluble cations K	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-9	9841	1	6	24	27	33	5	4	5.4	4.4	0.06	–	–	0.6	0.09	0.95	11	3	0	1.22
9-37	9842	17	11	17	15	13	6	21	5.6	4.4	0.44	–	–	2.6	0.05	0.49	10	3	0	1.27
37-70	9843	5	10	19	15	11	8	32	8.0	7.7	4.15	2.8	0.0	4.6	0.01	0.06	6	4	0	1.29
90-110	9844	3	6	15	16	11	10	39	8.6	7.9	2.03	4.3	0.0	4.2	0.01	0.04	~4	3	0	1.26

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-9	9841	0.2	0.1	0.4	2.0	0.1	2.7	3.8	71	40	500	300	400	10	20	<5	–
9-37	9842	5.2	0.1	3.4	5.2	0.0	13.9	12.9	100	50	200	1,850	950	10	20	20	–
37-70	9843	9.1	0.1	5.9	>50.0	–	>65.1	19.4	100	50	500	3,700	18,000	10	100	20	2.0
90-110	9844	10.4	0.0	6.7	31.6	–	48.7	19.3	100	50	450	3,350	20,750	20	40	20	4.0

Soil Classification	Suite Guinea Grass	Subsuite Pixoy
Soil correlation	FAO/UNESCO Eutric Planosol	USDA Soil Taxonomy Hapludalf

Described: 21.4.90

Location: Big Pond area across the New River from Shipyard (16Q CQ 332 829)

Landform: 2 degrees midslope on slight valley dissecting gently undulating plain in Lazaro Plain land system

Parent Material: Slopwash from siliceous drift over limestone

Vegetation: Dense low bush with great range of tree types: cohune, large oaks; botan, very tall palmettoes and white chechem

Site Drainage: Good

Surface: 1-2 cm continuous dry leaf litter

Sample no.	Depth (cm)	
OZ 72/1	0-16	N2. (black) with bleached sand grains; fine sandy loam; strong coarse crumb-granular; few fine pores; moist and friable; abundant roots, including chechem, of all sizes; no worms seen; clear regular boundary to:
OZ 72/2	16-44	5YR 2.5/1 (black); with bleached sand grains; medium sandy loam; moderate medium-fine angular blocky; many fine pores; moist and slightly firm; many roots of all sizes; gradual regular boundary to:
	44-52	10YR 3/2 (very dark greyish brown) with common medium very faint yellowish brown mottles; coarse sandy clay loam; strong medium angular blocky, with continuous dark coatings on all faces; common medium pores; moist and very firm; common medium and fine roots, clear slightly wavy boundary to:
OZ 72/3	52-120	10YR 3/4 (yellowish brown), with abundant medium distinct yellowish red and greyish brown mottles; coarse sandy clay loam; massive breaking to moderate medium angular blocky, with weak discontinuous clayskins, but continuous dark organic coatings, especially on vertical faces; common fine pores; moist and extremely firm-compact; few fine and medium roots; rare soft black ferrimanganiferous concretions.
Continued by auger		
	120-150	As above horizon
	150-180	Olive yellow sandy clay loam with common soft white calcareous patches.
	180-200	Light greyish brown medium sandy loam, non-calcareous.
	200-220	As above but with soft white calcareous patches.
	220-240+	Light grey non-calcareous medium sandy loam.

Note: This profile was originally chosen because of its extremely mixed vegetation. The deeper subsoil shows great heterogeneity of materials, presumably due to colluviation.

Samples sent to Central Farm.

Soil Classification	Suite Melinda	Subsuite Canquin
Soil correlation	FAO/UNESCO Dystric Cambisol	USDA Soil Taxonomy Fluventic Dystropept

Described: 28.4.90

Location: Macal River end of Francelia Line, Mountain Pine Ridge (15Q BP 965 645)

Landform: Near front edge of main dissected terrace of Macal River in Maya Mountains Floodplains. ½ degree slope

Parent Material: Riverine alluvium, almost entirely derived from Santa Rosa Group metasediments

Vegetation: Hardwood bush, possibly old secondary. Many moho; also quamwood, kakaya palms, trumpet near road; cowfoot, large cottontree

Site Drainage: Good

Surface: 1-3 cm continuous leaf litter

Sample no.	Depth (cm)	
OZ 73/1	0-20	7.5YR 4/2 (brown-dark brown); silty clay loam; strong coarse crumb; many medium and coarse pores; slightly moist and friable; abundant roots of all sizes, decreasing to many; rare fine rounded quartzite gravel; worms seen; diffuse boundary to:
OZ 73/2	20-42	10YR 5/6 (brownish yellow), with few fine faint patches of pale yellow; silty clay loam; massive breaking to moderate medium angular blocky, with rare weak clayskins; abundant medium and coarse pores; moist-dry, fragic (hard and compact *in situ*, crumbles in hand); common medium and fine roots; few coarse rounded sandstone boulders; few fine soft black ferrimanganiferous concretions; diffuse boundary to:
	42-75	7.5YR 5/4 (brown), with commmon medium faint light and yellowish brown mottles; silty clay; massive breaking to moderate coarse angular blocky with moderate discontinuous clayskins, especially on horizontal and oblique faces; abundant medium and fine pores; moist-dry, strongly fragic; rare fine roots; rare fine rounded sandstone gravel; few fine soft black ferrimanganiferous concretions; diffuse boundary to:
OZ 73/3	75-115	5YR 5/6 (yellowish red) with common fine faint reddish yellow mottles; silty clay; massive breaking to coarse angular blocky, with moderate almost continuous clayskins, especially strong on pore walls; many medium and faint pores; moist and strongly fragic; rare medium palm roots.
Continued by auger		
	115-200	Colours as above. Texture banded alternations of silty clay-silty clay loam. Consistence also variable, weakly-strongly fragic.
	200-220	Yellowish red fine sandy clay loam with many fine faint reddish yellow mottles; moist and firm.

Note: The exceptional feature of this soil is its consistence. When augered it appeared moderately friable but digging showed it to be highly fragic. The colours indicate that the compaction does not impede percolation and drainage, but the density of roots in the fragic lower subsoil is low, suggesting that mechanical impedance may be important.

Samples sent to Central Farm.

Soil Classification	Suite Ossory	Subsuite Cooma
Soil correlation	FAO/UNESCO Plinthic Acrisol	USDA Soil Taxonomy Plinthic Kandudult

Described: 30.4.90

Location: Junction of Raspa Road and Brunton Trail, Mountain Pine Ridge, (16Q BP 929 704)

Landform: Gentle (1 degree) rectilinear slope on old surface on metasedimentary plateau in Mountain Pine Plateau land system

Parent Material: Santa Rosa metasediments, mainly argillaceous, possible resorted by hillwash

Vegetation: *Pinus caribaea* with understorey of crabboe, *Hypericum* sp. and tufted grasses

Site Drainage: Good

Surface: 1-2 cm continuous needle litter

Sample no.	Depth (cm)	
OZ 74/1	0-10	10YR 5/4 (brown), with common medium distinct flecks of 7.5YR 5/6 (strong brown); silty loam; moderate medium subangular blocky breaking to strong medium crumb; few medium pores; moist and friable; many medium and fine roots; rare fragments of reddish weathering argillite; clear regular boundary to:
	10-28	7.5YR 6/6 (reddish yellow); extremely stony silty clay loam; stone-dominated structure with some interstitial weak fine crumb; rare fine pores; stone-dominated consistence with moist and friable interstitial fine earth; many medium and fine roots; abundant rounded quartzite and polished dark reddish brown-black ferrimanganiferous-coated weathering argillite; gradual regular boundary to:
	28-48	5YR 5/8 (yellowish red); stony silty clay; moderate fine angular blocky between stones; common medium and coarse pores; moist and friable between stones; common medium and fine roots; many stones, proportion of quartzite lower and of ferrimanganese coated argillite higher than in horizon above; diffuse boundary to:
OZ 74/2 (70-80)	48-130/150	2.5YR 5/8 (red) with clusters of common fine faint yellowish red mottles, but also areas of free of mottles; silty clay; weak medium-coarse subangular blocky with moderate discontinuous clayskins; many medium and coarse pores; moist and slightly friable; few decreasing to rare medium and fine roots, rare coarse pine roots; common medium slightly hard red and purple pieces of ferruginized weathering quartzite and few argillite; diffuse boundary to:
	130/150-150+	(One corner of pit only). *In situ* grey, purple, greenish grey horizontal weathering argillite. Also more weathered beds which are reddish silty clay; roots very rare.

Note: This profile characterizes the Cooma soils on the more stable upper planation surfaces of the Mountain Pine Plateau. The weathering rock fragments are less ferruginized than those in the younger and shallower Cooma profile of OZ 42.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm^3 a.d.s.
0-10	9845	2	2	10	11	11	26	38	4.8	4.3	0.04	3.3	0.20	3.39	17	1	–	0.82
70-80	9846	1	1	5	4	13	30	46	5.0	5.3	0.03	1.2	0.02	0.23	12	1	–	0.99

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			%
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	$CaCO_3$
0-10	9845	0.0	0.1	0.0	0.1	2.4	0.2	10.3	2	210	13,500	650	100	10	40	20	–
70-80	9846	0.0	0.1	0.1	0.0	0.0	0.2	2.1	10	250	15,900	450	<25	20	40	30	–

Soil Classification	Suite Stopper/Chacalte	Subsuite Pinol/San Lucas
Soil correlation	FAO/UNESCO Gleyic Luvisol	USDA Soil Taxonomy Haplaqualf
Described:	30.4.90	
Location:	1 km west of Augustine on Rio Frio road, Mountain Pine Ridge (16Q BP 870 775)	
Landform:	2 degrees gradient rectilinear lower slope-floor of 'dead end' valley where granite stream disappears beneath medium karst limestone (at Rio Frio Caves) in Vaca Hills land system	
Parent Material:	Mixed granite and Cretaceous limestone drift	
Vegetation:	Old secondary broadleaf bush with moho, trumpet, santa maria, all-spice and hogplum	
Site Drainage:	Imperfect	
Surface:	1 cm discontinuous leaf litter	

Sample no.	Depth (cm)	
OZ 75/1 (0-10)	0-5	10YR 3/2 (very dark greyish brown) with few bleached quartz grains; silty clay loam; moderate-strong coarse crumb; weak coatings on some root channel walls; common medium pores; moist and friable; many fine and medium roots; common quartz grit; worms seen; clear regular boundary to:
OZ 75/1 (0-10)	5-16	10YR 3/3 (dark brown) with common fine faint yellowish brown mottles and few bleached quartz grains; gritty loam; moderate medium sub-angular blocky breaking to moderate medium crumb; many coarse pores; moist and friable; common medium and fine roots; many angular quartz grit; clear regular boundary to:
	16-31	7.5YR 5/4 (brown) with many fine faint reddish and brownish yellow mottles; gritty clay; weak medium breaking to moderate fine angular blocky, with moderate discontinuous clayskins; common medium pores; moist-wet, slightly firm, slightly plastic and slightly sticky; medium roots; grit is subangular quartz and round black ferri-nanganiferous concretions, also few rounded quartz stones; gradual regular boundary to:
OZ 75/2	31-68	10YR 6/4 (light yellowish brown), with common medium distinct reddish yellowish, brownish grey, and black mottles; clay; weak medium angular blocky, with moderate continuous clayskins; few medium pores; moist and slightly friable; few medium and fine roots; discontinuous line of rounded quartz stones, common fine black ferrimanganiferous stains and few hard concretions; gradual regular boundary to:
OZ 75/3	68-90	10YR 7/2 (light grey), with many medium distinct yellow, reddish yellow, reddish brown and black mottles; clay; moderate coarse angular blocky with medium continuous clayskins; many medium and coarse pores; moist and slightly firm; rare fine and medium roots; many coarse black ferrimanganiferous stains; diffuse boundary to:
OZ 75/4 (110-120)	90-155+	5Y 7/1 (light grey), with many coarse prominent red and few black mottles; clay; weak medium angular blocky, with moderate continuous clayskins; common medium and coarse pores; moist and slightly firm; rare coarse roots; few fine black ferrimanganiferous stains.

Note: The distribution of grit and stones textures suggest that this soil is formed in a granitic overwash on limestone colluvium. This complexity is typical of the contact areas between the siliceous rocks in the Mountain Pine Plateau and the calcareous rocks of the Vaca Hills.

Samples sent to Central Farm.

Soil Classification	Suite Chacalte	Subsuite San Lucas
Soil correlation	FAO/UNESCO Pelli-eutric Vertisol	USDA Soil Taxonomy Pelludert

Described: 5.5.90

Location: 1.8 km west of Cohune Ridge (16Q BP 762 603)

Landform: 2 degree rectilinear toeslope in undulating plain in area close to undulating plain/high karst boundary of the Xpicilha Hills with Plains/ Vaca Hills (respectively) land systems

Parent Material: Hillwash from Cretaceous limestone.

Vegetation: Logged broadleaf forest, also with many hogplum and ramon

Site Drainage: Imperfect

Surface: 2-4 cm continuous dry leaf litter; rare narrow cracks; moderate (amplitude 15-20 cm) hogwallow microrelief

Sample no.	Depth (cm)	
	6-0	Dark reddish brown fibrous leaf litter within dense root mat.
	0-4	5YR 2.5/2 (black); loam; moderate fine crumb; few medium pores; moist-dry and friable; abundant medium and fine roots; clear regular boundary to:
OZ 76/1	4-22	5YR 2/1 (black) with rare fine faint reddish brown mottles; clay; strong medium-coarse angular blocky, with weak discontinuous coatings; few medium pores; moist-dry and very firm; common roots of all sizes; rare cream limestone grit; few slightly hard black ferrimanganiferous concretions; gradual regular boundary to:
OZ 76/2	22-60	10YR 4/2 (dark greyish brown) with many fine faint reddish and dark brown mottles; clay; massive – very coarse angular blocky, with strong continuous clayskins and slickensides; rare medium pores; moist and extremely firm; few-common medium and fine roots; rare limestone grit; many fine slightly hard black ferrimanganiferous concretions; diffuse boundary to:
OZ 76/3 (80-90)	60-120	Faint mixture of 10YR 4/1 (dark grey) and 7.5 YR 3/4 (dark brown); clay; massive-very coarse angular blocky with strong continuous slickensides; rare medium pores; moist and extremely firm; few medium palm roots; few limestone grit; abundant slightly hard black ferrimanganiferous concretions.
Continued by auger:		
	120-180	As above.
	180-220+	Dark grey clay with common medium faint dark brown mottles; moist and very firm; few limestone grit.

Note: This soil occurs quite close (<100m) to very shallow rocky soils. It emphasizes the spatial heterogeneity of the soils in Cretaceous limestone terrain of the Western Uplands. This soil appears to be quite mature, as shown by the decalcification, depth, and accumulation of organic C, total N and total P in the topsoil. However the analyses do not indicate any siliceous admixture in the parent material.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
4-22	9847	1	0	2	2	2	14	79	6.1	5.4	0.09	12.9	0.69	5.40	8	3	–	0.96
22-60	9848	1	1	2	2	2	10	83	5.2	4.0	0.04	12.5	0.17	1.12	7	2	–	1.02
80-100	9849	2	1	1	2	4	11	79	5.1	3.8	0.04	11.9	0.15	0.94	6	2	–	1.01

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
4-22	9847	0.1	0.2	5.7	>50.0	–	>56.0	67.5	>83	710	500	6,050	13,550	60	2,660	100	–
22-60	9848	0.2	0.1	3.1	44.9	0.1	48.3	57.2	84	150	400	5,900	8,950	50	2,940	70	–
80-100	9849	0.2	0.1	1.1	42.5	0.4	43.9	50.6	87	120	300	4,900	8,650	40	3,400	70	–

Soil Classification		Suite Chacalte	Subsuite Cabro
Soil correlation		FAO/UNESCO Rendzic Leptosol	USDA Soil Taxonomy Rendollic Eutropept
Described:		5.4.90	
Location:		1.5 km north-east of Caracol Ruins (16Q BP 759 549)	
Landform:		10 degrees rectilinear midslope in medium karst in Xpicilha Hills with Plains land system	
Parent Material:		Colluvium from Cretaceous limestone.	
Vegetation:		Medium broadleaf bush, with many cedar, also hogplum, gombolimbo, quamwood, cohune	
Site Drainage:		Good	
Surface:		1-3 cm continuous leaf litter; common limestone boulders, irregular microrelief from boulders and treefall	

Sample no.	Depth (cm)	
OZ 77/1	0-18	7.5YR 3/2 (dark brown); clay; strong medium breaking to strong fine subangular blocky; few medium pores; moist and slightly friable; many roots of all sizes; common limestone stones; gradual regular boundary to:
	18-65+	Boulders of hard white crystalline limestone with pockets and pipes of 7.5YR 3/4 (dark brown); clay; strong medium-fine subangular blocky, with weak discontinuous clayskins; few medium pores; moist and friable; common soft medium limestone stones as well as boulders.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-18	9850	3	1	1	1	5	11	78	7.9	6.8	0.18	13.8	1.10	7.73	7	6	3	0.84

		Exchangeable cations me/100 g a.d.s.								Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-18	9850	0.0	0.4	5.1	>50.0	–	>55.5	84.1	>66	670	950	6,850	33,200	40	1,250	90	4.0

Soil Classification	Suite Vaca	Subsuite Cuxu
Soil correlation	FAO/UNESCO Chromic Luvisol	USDA Soil Taxonomy Rhodudalf

Described: 5.5.90

Location: Moho Tree Camp on the Guacamallo-Caracol road (16Q BP 789 624)

Landform: 25 degrees irregular rectilinear lower slope in high karst terrain in Vaca Hills land system

Parent Material: Colluvium from Cretaceous ferruginous limestone

Vegetation: High broadleaf bush, probably logged, with ironwood, trumpet and botan

Site Drainage: Good

Surface: Thin discontinuous leaf litter. Occasional limestone boulders. Irregular microrelief due to boulder and old treefalls

Sample no.	Depth (cm)	
OZ 78/1	0-25	5YR 3/3 (dark reddish brown); clay; strong medium breaking to very strong fine subangular blocky; few pores; slightly moist, firm-slightly hard; many medium and fine and common coarse roots; few medium-coarse slightly hard limestone stones; termite nest; clear slightly wavy boundary to:
OZ 78/2	25-65	2.5YR 4/6 (red); clay; strong medium subangular blocky breaking to strong medium crumb, with moderate continuous clayskins; common medium pores; slightly moist and firm; common fine and few medium roots; common limestone stones and boulders; rare fine black ferri-manganiferous concretions; clear wavy boundary to:
	65-80+	Interlocking boulders (up to 50 cm across) of hard white pink crystalline limestone, with only thin interstitial pockets and pipes of red clay from the above horizon.

Note: This is typical of the shallow Cuxu soils on steepland over hard ferruginous (probably tuffaceous) limestones. Despite the bouldery surfaces and occurrence of boulders close to the surface, the potential root zone is quite deep.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-25	9851	1	1	2	2	3	15	76	6.3	5.8	0.11	9.2	0.81	5.87	7	4	–	0.94
25-65	9852	2	1	2	1	2	6	86	6.5	5.6	0.05	7.4	0.26	1.24	5	3	–	0.92

		Exchangeable cations me/100 g a.d.s.					TEB	Cation exchange capacity	Base sat.	Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	me % o.d.s.	me/100 g	%	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-25	9851	0.0	0.4	3.9	41.5	–	45.8	48.7	94	540	750	3,400	9,600	60	5,350	90	–
25-65	9852	0.0	0.1	0.8	30.8	–	31.7	34.3	92	220	600	3,050	6,550	50	3,660	70	–

Soil Classification	Suite Stopper	Subsuite Pinol (gleyed)
Soil correlation	FAO/UNESCO Gleyic Acrisol	USDA Soil Taxonomy Kandiaquult

Described: 7.5.90

Location: 1963 line, Mountain Pine Ridge, 1.5 km west of Chiquibul Road (16Q BP 893 803)

Landform: Flat low area of granitic plateau in Mountain Pine Plateau land system, 0.5 km east of granite-limestone boundary

Parent Material: Granitic slopwash

Vegetation: Poor Mountain Pine Ridge, with sparse stunted *Pinus caribaea* and crabboo set in tussock grass savanna

Site Drainage: Imperfect-poor

Surface: Thin discontinuous grass litter

Sample no.	Depth (cm)	
OZ 79/1	0-16	Mixed 10YR 3/2 (very dark greyish brown) and 10YR 5/2 (greyish brown), with many bleached quartz grit; gritty loam; weak fine sub-angular blocky – coarse crumb; moist and friable; many medium and fine roots; abundant angular quartz grit; gradual regular boundary to:
OZ 79/2	16-31	10YR 6/4 (light yellowish brown); stony loamy grit; stony-single grain; stony consistence with interstitial moist and friable; many medium and fine roots; abundant angular quartz grit; many hard coarse rounded dark brown-black ferrimanganiferous coated quartz stones and concretions; few soft black ferrimanganiferous stains; clear regular boundary to:
	31-46	10YR 6/6 (brownish yellow); gritty loam; weak medium-fine subangular blocky; moist and friable; common medium and fine roots; abundant angular quartz grit; gradual regular boundary to:
	46-65	2.5Y 7/4 (pale yellow) with many medium prominent strong brown and reddish yellow mottles; gritty loam; weak-moderate medium angular blocky, with moderate discontinuous clayskins against stones; many coarse pores; moist and slightly firm; few medium and fine roots; abundant angular quartz grit; gradual slightly wavy boundary to:
OZ 79/3	65-104	2.5Y 8/2 (white), with many coarse prominent dark red and many medium faint pale brown and brownish yellow mottles; gritty clay; massive breaking to weak medium angular blocky, with moderate discontinuous clayskins, especially against stones; common coarse pores; moist and firm; rare fine roots; many angular quartz grit; diffuse boundary to:
	104-135	5Y 8/2 (white) with many medium prominent strong and dark brown, and many medium faint 5GY 7/1 (light greenish grey) and 5G 7/2 (pale green) mottles; loamy grit-weathering granite; massive breaking to weak fine angular blocky, with weak discontinuous clayskins; common coarse pores; moist-wet and slightly friable; no roots; abundant quartz grit; common soft white flecks of kaolinized feldspar.

Continued by auger:

	135-200+	As above but greenish colours increase, and soil becomes wetter.

Samples sent to Central Farm.

Soil Classification	Suite Stopper	Subsuite Pinol
Soil correlation	FAO/UNESCO Dystric Cambisol	USDA Soil Taxonomy Dystropept

Described: 7.5.90

Location: 1.7 km south-east of Augustine on Inner Circle, Mountain Pine Ridge (16Q BP 896 762)

Landform: Recently eroded surface wash on gentle (1-2 degrees) mid-lower slope in rolling dissected granitic plateau in Mountain Pine Plateau land system

Parent Material: Granite

Vegetation: Mountain Pine Ridge, with common medium sized *Pinus caribaea*, *Micronia* sp. and *Hypericum* sp.

Site Drainage: Good

Surface: Discontinuous needle litter layer up to 2 cm thick

Sample no.	Depth (cm)	
OZ 80/1	0-12	10YR 5/4 (yellowish brown), with common medium faint 10YR 6/6 (brownish yellow) mottles; coarse sandy loam; moderate medium breaking to fine subangular blocky-coarse crumb; moist and friable; common medium and fine roots; common angular quartz grit; clear regular boundary to:
OZ 80/2	12-33/36	10YR 7/6 (yellow) with common coarse distinct red mottles; coarse sandy loam; weak coarse breaking to moderate fine angular blocky, with rare discontinuous clayskins; few coarse pores; moist and friable; common medium and fine roots; common angular quartz grit; few subrounded medium reddish and brownish ferruginized granite fragments; clear slightly wavy boundary to:
OZ 80/3	33/36-105+	Distinct patches of: 10YR 8/1 (white), weathering granite; massive; moist-dry and slightly hard; rare fine roots: and prominently variegated 10R 4/8 (red) and 10YR 7/8 (yellow); gritty clay loam; weak fine angular blocky, with weak discontinuous clayskins; moist and slightly friable; few fine roots with 4 cm wide pipe of soil from above horizon going to 80cm, probably down old taproot channel.

Note: This demonstration pit is located in area of previous logging activity. The lack of a dark topsoil and the appearance of weathering granite at less than 40 cm suggests that the profile has been severely truncated, probably during or just after the logging operations. Nearby areas show substantial recent gullying.

Samples sent to Central Farm.

Soil Classification	Suite Vaca	Subsuite Cuxu
Soil correlation	FAO/UNESCO Skeletal Eutric Cambisol	USDA Soil Taxonomy Skeletal Rendoll

Described: 9.5.90

Location: 5 km south of Arenal (16Q BP 718 783)

Landform: Upper stepped valley bottom in high karst in Vaca Hills land system. Slope 2 degrees

Parent Material: Cretaceous limestone. Some colluvium and old Maya linear stone heaps, nearest is about 5 m upslope

Vegetation: Bone. Recently burnt old warmil, not yet planted

Site Drainage: Good

Surface: Ash and some sticks, many with pinkish post-fire fungi. Many limestone stones and boulders. Few fine cracks, accentuating topsoil blocky structure. Some old cohune holes

Sample no.	Depth (cm)	
OZ 81/1	0-11	7.5YR 3/2 (dark brown); clay; weak medium subangular blocky breaking to moderate fine crumb; common fine pores; moist and friable, slightly plastic and very slightly sticky; common roots of all sizes; common medium-coarse subrounded fragments of hard limestone; some ash down cracks in upper few cm; clear slightly wavy boundary to:
	11-27/36	Tightly interlocked stone line of subangular-subrounded hard white and pale brown crystalline limestone, with small interstitial pockets of 10YR 3/3 (dark brown); clay; moderate fine subangular blocky, with weak discontinuous moisture films; few fine pores; moist and slightly firm, slightly plastic and very slightly sticky; few medium and fine roots; clear wavy boundary to:
OZ 81/2	27/36-48/57	10YR 3/3 (dark brown); clay; moderate medium breaking to fine subangular blocky, with moderate continuous clayskins; common medium and coarse pores; moist and slightly friable, slightly plastic but not sticky; few medium and fine roots; few fine limestone fragments; few fine hard black ferrimanganiferous concretions; clear wavy boundary to:
	48/57-70	Discontinuous stone line of hard limestone boulders and stones moderately spaced and set in 7.5 YR 5/4 (brown); gravelly clay; gravelly-massive structure with stong discontinuous clayskins; few fine pores; moist and slightly firm; rare fine roots; clear slightly wavy boundary to:
	70-85+	7.5YR 5/4 (brown); stony gravelly clay; structure, clayskins, porosity, consistence and roots as in the interstitial material of the horizon above; common limestone fragments, but fewer and finer than in stone line above.

Note: The upper stone line is thought to be artificial, being material slumped out from the stone heap about 5 m upslope. The stone heap appears to have been constructed where a number of limestone outcrops crossed the valley. The stepped form of the valley was therefore natural but has probably been accentuated by the silt trap action of the stone heap. The lower, less continuous stone line is thought to be natural.

Samples sent to Central Farm.

Soil Classification	Suite Melinda	Subsuite Sennis
Soil correlation	FAO/UNESCO Dystric Fluvisol	USDA Soil Taxonomy Dystric Tropofluvent

Described: 16.5.90

Location: 4 km south of Sibun Crossing on Manatee Road (16Q CQ 413 147)

Landform: Slight backswamp declivity on alluvial wash of Sibun in Lower Belize Floodplains land system

Parent Material: Siliceous river alluvium

Vegetation: Low riverain forest with many palms, including *Schippia*, botan, young yemeri and allspice

Site Drainage: Slightly impeded

Surface: 1 – 3 cm continuous leaf litter. Very slight hogwallow microrelief

Sample no.	Depth (cm)	
OZ 82/1	0-9	10YR 5/4 (yellowish brown) dry, 10YR 4/4 (dark yellowish brown) moist; silty loam; strong coarse crumb; few medium and coarse pores; moist-dry and friable; many roots of all sizes; rare hard medium fragments of reddish sandy ferricrete; worms seen; clear regular boundary to:
	9-28	10YR 6/4 (light yellow brown) moist and dry; stony and gritty clay loam; stony structure with interstitial strong medium crumb, with rare weak clayskins; few medium and coarse pores; stony consistence with interstitial moist-dry and friable-loose; many medium and fine roots, abundant medium and coarse dark red and purple quartzite, ferricrete and much quartz grit; clear slightly wavy boundary to:
OZ 82/2	28-44	10YR 6/6 (brownish yellow), with common medium faint yellowish red mottles; gritty silty clay; moderate medium breaking to strong fine angular blocky, with moderate discontinuous clayskins; many coarse and medium pores; moist and firm; few medium and fine roots; common quartz grit and rare fragments of reddish ferricrete; gradual regular boundary to:
OZ 82/3	44-88	10YR 7/6 (yellow), with many medium distinct yellowish red, red and pale yellow mottles; silty clay; massive breaking to moderate fine angular blocky, with moderate discontinuous clayskins; common fine pores; moist and moderately fragic (compact *in situ* crumbling to friable); few fine roots; few coarse dark red sandy ferricrete; diffuse boundary to:
OZ 82/4	88-115	Distinctly variegated mixture of 10R 4/8 (red) stony silty clay and 10YR 8/6 (yellow) and 2.5 Y 8/4 (pale yellow) silty clay; massive breaking to moderate fine angular blocky with weak discontinuous clayskins; common medium and fine pores; moist and slightly fragic; rare fine roots; red patches are patchily indurated to give reddish ferricrete stones.
Continued by auger		
	115-200+	As above but with decreasing frequency of ferricrete stones.

Note: This profile has been assigned to Sennis Subsuite on account of its strongly mottled subsoil. However, the high silt contents throughout tend to gainsay a bisequent origin. The ferricrete may be a slopwash feature from the nearby Pine Ridge.

Samples sent to Central Farm.

Soil Classification	Suite Puletan	Subsuite Bocotora
Soil correlation	FAO/UNESCO Plinthic Planosol	USDA Soil Taxonomy Plinthaquult

Described: 17.5.901

Location: Cornhouse Creek Work, Manatee Road (16Q CQ 456 106)

Landform: 2 degrees lower slope down to swamp on middle plain subunit in Belize Plain land system, with occasional protruberant limestone hill (medium karst) in Hummingbird Plain with Hills land system (Figure 8 in main text)

Parent Material: Early Pleistocene coastal alluvium, derived from Maya Mountains siliceous rocks

Vegetation: Logged Pine Ridge, with moderate pines (*Pinus caribaea*), and scattered sandpaper trees and wild crabboo in tussocky grasses. Palmettoes 30 m downslope

Site Drainage: Good

Surface: Sparse and discontinuous grass and pine needle litter

Sample no.	Depth (cm)	
OZ 83/1	0-8	10YR 7/2 (light grey) dry, 10YR 5/2 (greyish brown) moist; loamy coarse sand; moderate medium-fine subangular blocky breaking to single grain; few medium pores; moist-dry and soft; common roots of all sizes; clear regular boundary to:
	8-30	2.5Y 8/6 (yellow) with few medium very faint light grey mottles; loamy medium sand; extremely weak fine subangular blocky breaking to single grain; many fine pores; moist and very friable; common medium and fine and few coarse roots; clear regular boundary to:
	30-58	5YR 8/4 (pale yellow); medium sand; single grain; moist and extremely loose; few medium and fine roots; rare fragments of hard dark brown ferricrete; gradual slightly wavy boundary to:
OZ 83/2	58-110	10YR 7/8 (yellow) with many fine faint reddish yellow and pale yellow mottles; loamy medium-coarse sand-sandy loam; weak medium angular blocky breaking to single grain; common coarse pores; moist and very friable; few medium and fine and rare coarse roots; rare medium fragments of hard dark brown ferricrete, and common angular quartz grit; clear regular boundary to:
	110-145	10YR 7/3 (very pale brown), with many medium distinct strong brown and yellowish brown mottles and prominent red (slightly indurated) mottles; gritty clay loam; weak medium-coarse breaking to moderate fine angular blocky with weak discontinuous clayskins; abundant medium and coarse pores; moist and very firm; rare fine roots; many dark red hard fragments of plinthite indurating to ferricrete; abundant angular quartz grit; diffuse boundary to:
	145-160+	10YR 8/2 (white) with many coarse distinct yellowish brown and many coarse prominent red and dark red mottles, some indurated; gritty clay loam; massive breaking to weak medium angular blocky, with moderate discontinuous clayskins; few coarse pores; moist and extremely firm-compact, no roots; common fragments of red plinthite hardening to ferricrete; many angular quartz grit.

Note: This profile has a deep sandy top, similar to the soils of Crooked Tree Subsuite, but there is no trace of an illuvial organic Bh horizon. The subsoil differs from those of Crooked Tree in that the red mottles are plinthitic and indurating to ferricrete.

Samples sent to Central Farm.

Soil Classification	Suite Puletan	Subsuite Bocotora
Soil correlation	FAO/UNESCO Dystric Planosol	USDA Soil Taxonomy Plinthaquult

Described: 17.5.90

Location: Cornhouse Creek Work, Manatee Road (16Q CQ 447 116)

Landform: Flat upper surface on medium plain subunit in Belize Plain land system close (100 m) to protruberant limestone hill (medium karst of Hummingbird Plain with Hills land system)

Parent Material: Pleistocene coastal alluvium

Vegetation: Fairly dense pine ridge with closely spaced medium pines (*Pinus caribaea*), oak, sandpaper tree, wild crabbo. Nearby clump of palmetto with associated *Schippia* palm. Dense ground cover of grasses and low thorny leguminous shrub

Site Drainage: Good

Surface: Continuous leaf and needle litter 1 – 3 cm thick

Sample no.	Depth (cm)	
OZ 84/1	0-14	10YR 5/2 (greyish brown) dry, 10YR 4/1 (dark grey) moist; loamy coarse sand-sandy loam; moderate coarse crumb; few medium and coarse pores; dry and slightly hard; common coarse and many fine and medium roots; clear regular boundary to:
OZ 84/2	14-36	10YR 7/8 (yellow); coarse sandy loam; weak medium angular blocky many coarse pores; dry and slightly hard; few coarse and common medium and fine roots; many angular quartz grit; gradual regular boundary to:
	36-55	10YR 7/8 (yellow), with few medium distinct dark reddish slightly indurated patches; gritty loam-clay loam; few coarse pores; dry and very hard (-slightly fragic); common medium and fine roots; many angular quartz grit; few hard coarse fragments of reddish sandy plinthite hardening to ferricrete; clear regular boundary to:
OZ 84/3	55-110	10YR 7/4 (very pale brown), with many medium and coarse prominent dark red and distinct reddish brown, yellow, and yellowish brown mottles; coarse sandy-gritty clay loam; weak medium angular blocky with very weak discontinuous clayskins; few medium pores; moist and very firm-fragic; coarse pine root runs laterally, few medium and fine roots; many coarse hard-slightly hard fragments of dark reddish sandy plinthite- ferricrete; diffuse boundary to:
	110-120+	10YR 8/1 (white), with many coarse prominent dark red and red mottles; gritty clay loam; massive breaking to weak fine crumb; common coarse pores; moist and extremely hard-fragic; few medium and fine roots; common dark reddish plinthite-ferricrete stones; abundant quartz grit.

Note: The coarse pine root, presumably a taproot, is deflected obliquely and unable to penetrate the extremely hard lower subsoil. The abundant angular quartz grit in the subsoil gives the appearance of well-weathered granite. The combination of hard consistence and quartz grit gives these horizons their characteristic 'grinding' feel on the auger.

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-14	9853	13	20	26	14	10	5	12	4.7	4.1	0.04	1.4	0.14	2.54	18	3	–	1.14
14-36	9854	19	16	16	10	10	4	25	4.2	4.1	0.03	0.8	0.04	0.28	7	1	–	1.15
36-55	9855	25	18	8	4	4	6	35	4.2	3.9	0.03	1.0	0.02	0.09	~4	1	–	1.15

		Exchangeable cations me/100 g a.d.s.								Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-14	9853	0.0	0.1	0.4	1.3	1.1	1.8	7.8	23	70	650	250	250	10	20	<5	–
14-36	9854	0.0	0.0	0.1	0.1	0.9	0.2	2.4	8	60	1,450	300	<25	<5	20	10	–
36-55	9855	0.0	0.0	0.3	0.0	2.7	0.3	3.8	8	70	4,400	450	<25	10	20	20	–

Soil Classification	Suite Tintal	Subsuite Sibal-Pucte
Soil correlation	FAO/UNESCO Dystric Gleysol	USDA Soil Taxonomy Dystric Tropaquept

Described: 17.5.90

Location: Sally Pond Pine Ridge area, Manatee Road (16Q CQ 428 136)

Landform: Flat dense marsh forest plain in Sibal Swamps land system

Parent Material: Riverine alluvium

Vegetation: Low dense riverain forest with many small pucte, few small sapote. Many ground and epiphytic bromeliads. Much moss on stems and branches

Site Drainage: Poor

Surface: Thin discontinuous leaf litter. Marked hogwallow microrelief of amplitude up to 35 cm, at 3-6 m spacing

Sample no.	Depth (cm)	
OZ 85/1	0-15	7.5YR 3/2 (dark brown); clay loam; moderate medium crumb; common medium pores; moist and very friable; many medium and fine roots; gradual regular boundary to:
	15-28	10YR 5/2 (greyish brown), with few medium faint yellowish brown mottles; clay; moderate medium breaking to moderate fine angular blocky, with moisture films; moist-wet and slightly friable, plastic and slightly sticky; few medium and fine roots; diffuse boundary to:
OZ 85/2	28-85	10YR 6/1 (grey-light grey), with few medium faint yellowish brown mottles; clay; moderate-weak medium angular blocky, with moisture films and moderate discontinuous clayskins; few medium pores; wet and plastic, slightly sticky; few fine roots; wet by throughflow especially along root channels;
OZ 85/3	85-125+	Faintly variegated fine mixture of 10YR 6/1 (grey-light grey) and 10YR 7/3 (very pale brown), with many fine distinct reddish yellow mottles; clay; massive breaking to weak fine angular blocky with moisture films and weak discontinuous clayskins; few fine pores; moist-wet and slightly firm, plastic and very slightly sticky; no roots; further inflow of water as throughflow.

Note: This profile was originally dug to characterize Sibal Subsuite. However, the relatively low organic matter content and relatively dry subsoil suggest that it is marginal towards the seasonal gleys of Pucte Subsuite.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-15	9856	1	0	0	1	2	11	85	5.7	5.6	0.15	6.9	0.84	9.87	12	4	3	0.73
28-85	9857	4	2	3	2	2	7	80	6.6	6.0	0.06	3.3	0.07	0.41	6	2	0	0.95
90-110	9858	3	3	5	4	4	10	71	8.1	6.6	0.08	2.8	0.04	0.15	4	3	0	1.09

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-15	9856	0.1	0.3	3.1	33.4	–	36.9	40.0	92	330	4,200	2,350	7,950	20	110	70	–
28-85	9857	0.1	0.1	2.3	12.2	–	14.9	14.7	99	100	4,700	2,050	2,400	20	90	70	–
90-110	9858	0.2	0.1	2.6	13.0	–	15.9	14.4	100	70	5,450	1,800	2,400	20	120	50	–

Soil Classification	Suite Ossory	Subsuite Granodoro
Soil correlation	FAO/UNESCO Dystric Cambisol	USDA Soil Taxonomy Dystropept

Described: 1.6.90

Location: 3.3 km north-north-east of Engineer Camp (16Q BP 874 425)

Landform: Gentle (4 degrees) rectilinear lower slope of low hill among high karst in Xpicillia Hills with Plains land system

Parent Material: Santa Rosa Group metasedimentary argillite or Margaret Creek Formation shale

Vegetation: Low poley broadleaf forest with young rosewood, santa maria, allspice and pucte trees. Few botan. Some logged rosewood stumps

Site Drainage: Good

Surface: Thick (3-5 cm) leaf litter. Slight treefall microrelief

Sample no.	Depth (cm)	
	4-0	7.5 YR 3/2 (dark brown); leaf litter; foliar-fibrous; moist and very loose; abundant fine roots; clear regular boundary to:
OZ 86/1 (0-10)	0-4	10YR 5/3 (brown), with common medium faint dark brown and greyish brown mottles; silty clay loam; moderate medium angular blocky breaking to moderate fine crumb; few coarse and common medium pores; moist and slightly firm, with 'crisp' feel; many fine and medium roots; few fine fragments of slightly hard brownish weathering argillite; gradual regular boundary to:
OZ 86/1 (0-10)	4-22	2.5Y 6/4 (light yellowish brown) with few fine faint reddish yellow and grey mottles; clay; moderate coarse breaking to medium subangular blocky, with weak discontinuous clayskins especially on root channels; many coarse and medium pores; moist and slightly firm; common roots of all sizes; rare fine pieces of slightly hard brownish weathering argillite; gradual regular boundary to:
OZ 86/2	22-47	10YR 6/8 (brownish yellow), with many fine distinct yellowish red and strong brown mottles; silty clay; moderate medium lightly packed angular blocky with moderate continuous 2.5Y 7/8 (yellow) clayskins; common coarse and medium pores; moist and firm; common medium palm and few fine tree roots; common fine and medium fragments of slightly hard reddish, yellowish and orange weathering argillite or shale; clear regular boundary to:
	47-60+	Flat bedded hard greyish and yellowish argillite with thin skins of yellowish clay between layers.

Note: This profile was 50 m across slope from an area of argillaceous soils with markedly dark coloured blocky topsoils, influenced by wash from the limestone outcrops and boulders upslope.

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm³ a.d.s.
0-10	9859	1	1	9	16	16	32	25	5.0	4.6	0.05	1.8	0.17	1.91	11	1	–	1.04
22-47	9860	2	0	1	1	7	38	51	4.6	4.0	0.04	2.9	0.14	0.67	5	1	–	1.00

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-10	9859	0.0	0.1	1.5	5.7	0.0	7.3	11.2	65	170	11,800	2,950	1,300	10	60	20	–
22-47	9860	0.1	0.2	3.7	5.4	0.9	9.4	13.3	71	270	23,800	7,150	950	40	30	100	–

Soil Classification	Suite Ossory	Subsuite Granodoro
Soil correlation	FAO/UNESCO Dystric Cambisol	USDA Soil Taxonomy Dystropept

Described: 1.6.90

Location: 2.5 km north-north-east of Engineers Camp (16Q BP 863 423)

Landform: Gentle (2 degrees) rectilinear lower slope running down to upper reaches of Grano de Oro Creek, in siliceous undulating plain subunit in Xpicilha Hills with Plains land system

Parent Material: Mixed Santa Rosa quartzite and argillite or Margaret Creek Formation shales

Vegetation: Tall Broken Ridge-Broken Pine Ridge rare pines (*Pinus caribaea*), many young and medium santa maria. Tall botan palms

Site Drainage: Good

Surface: Thick (4-8 cm) leaf litter. Slight treefall microrelief

Sample no.	Depth (cm)	
	7-0	Dark brown leaf and twig litter; fibric-sapric; moist and loose; abundant roots of all sizes; clear regular boundary to:
	0-6	7.5YR 3/2 (dark brown); humic silty loam; moderate very fine crumb; moist and extremely friable; many roots of all sizes; clear regular boundary to:
NOT SAMPLED	6-17/27	10YR 6/3 (pale brown) with common medium very faint pale brown and pale yellow and few very fine very faint reddish yellow mottles; loamy medium sand-sandy loam; common coarse pores; moist and very firm; common medium and fine, and few coarse roots; clear regular oblique boundary to:
	17/27-26/32	10YR 6/2 (light brownish grey) with many medium distinct reddish yellow, brownish yellow and yellow mottles; medium sandy loam; moderate medium angular blocky; common medium pores; moist and friable; few medium and fine roots; clear regular oblique boundary to:
	26/32-42/46	7.5YR 8/2 (pinkish white) with common medium faint light grey and yellow mottles; gritty-coarse sandy loam; weak medium angular blocky with rare discontinuous weak clayskins; many coarse and medium pores; moist and friable; few medium and fine roots; abundant angular quartz grit; clear regular slightly oblique boundary to:
	42/46-60+	10YR 6/6 (brownish yellow) with many medium prominent and grey mottles; slightly gritty clay; massive breaking to weak medium angular blocky with weak discontinuous clayskins; rare medium pores; moist and slightly firm; few fine roots; few quartz fine stones; grit is plinthitic haematite, which smears bright red.
Continued by auger:		
	60-80	As above.
	80-120	Mixed yellow and grey very soft weathering argillite-silty clay; moist and firm.
	120+	Yellow and grey weathering argillite; harder and drier than above.

Note: This profile was dug to show the variability of the Granodoro soils, reflecting the lithological heterogenity of the Santa Rosa metasediments and further complicated by the patchy remnants of the Cretaceous limestone cap or Margaret Creek Formation basal limestone. The granulometric distinction of the sandy upper horizons and their oblique alignment parallel to the gentle dip of the underlying strata suggests that the soil has developed on sedentary mixed beds, rather than in a sandy slopewash over argillite.

This profile was not sampled.

Soil Classification	Suite Ossory	Subsuite Machiquila
Soil correlation	FAO/UNESCO Haplic Luvisol	USDA Soil Taxonomy Hapludalf

Described: 1.6.90

Location: Engineers Camp (16Q BP 840 417)

Landform: Flat area in siliceous undulating plain subunit with scattered protruberant limestone hills in Xpicilha Hills with Plains land system

Parent Material: Outwash from Santa Rosa metasedimentary or Margaret Creek Formation argillaceous hills, overlying Cretaceous limestone

Vegetation: Medium Broken Ridge with pucte, hogplum, achioti stick and onion vine

Site Drainage: Good

Surface: 1-3 cm continuous leaf litter

Sample no.	Depth (cm)	
OZ 88/1	0-10	10YR 5/4 (yellowish brown); silty loam; moderate fine subangular blocky breaking to moderate medium crumb; common medium pores; slightly moist and slightly friable; many medium and fine roots; clear regular boundary to:
OZ 88/2	10-32	5YR 5/6 (yellowish red); clay; strong medium angular blocky, with moderate discontinuous clayskins; common coarse pores; slightly moist and firm; few roots of all sizes; few fine hard round black ferri-manganiferous concretions; gradual regular boundary to:
	32-56	5YR 7/3 (pink) with few fine faint red and pale brown mottles; clay; massive breaking to weak fine angular blocky, with moderate continuous clayskins; few medium pores; moist and slightly firm; rare fine roots; rare fine rounded quartz stones; gradual regular boundary to:
OZ 88/3	56-110	10YR 8/3 (very pale brown) with many fine faint yellowish brown and reddish yellow mottles; clay; massive breaking to moderate fine angular blocky-fine platy, with moderate continuous clayskins; moist and firm; rare medium roots; diffuse boundary to:
OZ 88/4	110-160	10YR 6/6 (brownish yellow), with common medium faint white mottles and common distinct black ferrimanganiferous stains; clay; massive breaking to moderate fine angular blocky, with moderate discontinuous clayskins; few fine pores; moist-wet and firm; no roots; common soft black ferrimanganiferous concretions; clear slightly wavy boundary to:
	160-170	Slightly hard pinkish white limestone

		Particle size class																
		Sand				Silt		Clay	pH		Electrical conductivity	Moisture	Total N	Organic C		Available P ppm		W/V
Depth (cm)	Lab no.	Coarse	Medium	Fine	Very fine	Coarse	Fine		1:5 H_2O	1:5 1M KCl	ms/cm 1:5H_2O	% o.d.s.	% o.d.s.	% o.d.s.	C:N ratio	Bray	Olsen	g/cm³ a.d.s.
0-10	9861	4	1	3	6	36	28	22	4.9	4.6	0.05	2.5	0.22	2.46	11	2	–	1.03
10-32	9862	4	1	2	3	7	17	66	4.6	3.9	0.03	5.6	0.08	0.79	10	2	–	1.03
70-90	9863	3	1	2	4	7	19	64	4.8	3.9	0.03	6.0	0.03	0.20	7	2	–	1.06
120-140	9864	1	1	1	4	7	17	69	6.9	6.2	0.06	6.9	0.01	0.09	9	3	–	1.13

		Exchangeable cations me/100 g a.d.s.								Total content (ppm)				Trace elements (ppm)			
Depth (cm)	Lab no.	Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	P	K	Mg	Ca	Cu	Mn	Zn	% $CaCO_3$
0-10	9861	0.1	0.1	1.4	8.0	0.0	9.6	13.3	72	130	1,000	1,100	1,650	20	770	30	–
10-32	9832	0.2	0.2	2.8	14.5	2.4	17.7	23.7	75	100	2,850	3,550	2,850	30	150	60	–
70-90	9863	0.1	0.3	2.4	17.8	1.6	20.6	26.6	77	70	3,850	3,800	3,700	30	720	70	–
120-140	9864	0.2	0.3	2.8	26.7	–	30.0	30.5	98	80	3,300	4,550	5,450	30	1,120	90	–

Soil Classification	Suite Altun Ha	Subsuite Rockstone
Soil correlation	FAO/UNESCO Rendzic Leptosol	USDA Soil Taxonomy Lithic Eutropept

Described: 6.6.90

Location: J F Parsons Inc., Salt Creek (16Q CQ 585 527)

Landform: Gentle (2 degrees) upper slope of low flint ridge in flat plain subunit in Jobo Plain land system

Parent Material: Flinty sand slopewash and old mangrove mud over Doubloon Bank Group soft marly limestone

Vegetation: Young Tahiti lime plantation with much low secondary regrowth, including much grass

Site Drainage: Good

Surface: Thin discontinuous leaf and grass litter

Sample no.	Depth (cm)	
OZ 89/1	0-9	7.5YR 3/2 (dark brown); loamy coarse sand – sandy loam; weak medium subangular blocky breaking to single grain; moist and friable; many medium and fine roots; few fine and medium flint stones; clear regular boundary to:
	9-34	7.5YR 5/2 – 10YR 5/2 (brown-greyish brown); extremely stony and bouldery sandy loam; structure dominated by stones but pockets of interstitial fine earth are moderate fine subangular blocky; many coarse pores; moist and slightly firm; few fine roots; abundant flint stones and boulders, including flat slabs, up to 50 cm diameter, with moderate-thin coatings of surface lime; gradual regular boundary to:
	34-65	Continuation of same dense layer of flint boulders, slabs and stones, but interstitial fine earth is mixed 10YR 6/6 (yellowish brown) and 10YR 7/2 (light grey); clay; stony structure but clay is massive breaking to moderate fine angular blocky, with moderate discontinuous clayskins; few medium and coarse pores; moist and slightly firm; few fine roots; abundant flint boulders and stones as above but lime coatings are thicker; gradual regular boundary to:
OZ 89/2	65-80	Mixed 2.5Y 7/2 (light grey), 10YR 7/4 (very pale brown) and 10YR 6/6 (yellowish brown); clay; weak medium angular blocky with moderate continuous clayskins; moist and firm, slightly plastic and non-sticky; rare fine roots; few medium flint stones; common white soft calcareous patches.
Continued by auger		
	80-100+	Mixed white and pale yellow soft weathering argillaceous marl; massive; no pores; moist and slightly firm.

Note: The upper horizons of this soil are typical of the very stony sandy upland soils of the Salt Creek area. The gleyed clay subsoil appears to be an old mangrove deposit on top of the comminuted coral limestone base. The source and mode of emplacement of the large flint boulders is not known.

Depth (cm)	Lab no.	Particle size class: Sand, Coarse	Sand, Medium	Sand, Fine	Sand, Very fine	Silt, Coarse	Silt, Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-9	9865	7	16	19	19	23	8	8	5.6	5.5	0.06	0.9	0.12	1.26	10	2	1	1.19
65-80	9866	3	3	4	6	6	17	61	8.5	7.1	0.20	8.1	0.03	0.17	6	3	0	1.07

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s.: Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm): P	K	Mg	Ca	Trace elements (ppm): Cu	Mn	Zn	% $CaCO_3$
0-9	9865	0.1	0.2	1.0	5.4	–	6.7	7.0	96	60	100	500	1,100	<5	90	<5	–
65-80	9866	1.0	0.2	4.1	>50.0	–	>55.3	38.9	100	70	850	6,600	65,650	10	230	50	14.0

Soil Classification		Suite Turneffe	Subsuite Shipstern
Soil correlation		FAO/UNESCO Eutric Leptosol	USDA Soil Taxonomy Tropaquent
Described:		28.8.89	
Location:		North-western corner of Laguna de San Pedro, Ambergris Cay (16Q CQ 988 843)	
Landform:		Coral flat in mangrove subunit of Corozal Saline Swamps land system	
Parent Material:		Red clay pocket in coral	
Vegetation:		Bare	
Surface:		Bare	
Sample no.	Depth (cm)		
OZ Auger 380	0-8/25	Reddish brown; clay; massive breaking to weak medium crumb; moist, grading to wet, friable, plastic and slightly sticky; many pores; clear wavy boundary to:	
	8/25+	Hard coral.	

ANALYSIS **NORTH BELIZE 1989-1990** **Auger 380**

Depth (cm)	Lab no.	Particle size class: Sand Coarse	Sand Medium	Sand Fine	Sand Very fine	Silt Coarse	Silt Fine	Clay	pH 1:5 H_2O	pH 1:5 1M KCl	Electrical conductivity ms/cm 1:5H_2O	Soluble cations me/100 g Na	Soluble cations K	Moisture % o.d.s.	Total N % o.d.s.	Organic C % o.d.s.	C:N ratio	Available P ppm Bray	Available P ppm Olsen	W/V g/cm^3 a.d.s.
0-8/25	9018	1	1	1	1	4	22	70	8.2	8.2	19.6	92.5	0.8	8.6	0.14	1.39	10	5	1	0.99

Depth (cm)	Lab no.	Exchangeable cations me/100 g a.d.s. Na	K	Mg	Ca	Al	TEB me % o.d.s.	Cation exchange capacity me/100 g	Base sat. %	Total content (ppm) P	K	Mg	Ca	Trace elements (ppm) Cu	Mn	Zn	% $CaCO_3$
0-8/25	9018	13.5	3.7	37.7	14.1	–	69.0	16.6	100	370	9,700	29,300	5,350	10	240	40	1.0

APPENDIX 4: SOIL OBSERVATIONS

Pit Observations

Profile/Pit no.	Suite	Subsuite
OZ 1	Guinea Grass	Pixoy
OZ 2	Pembroke	Louisville
OZ 3	Guinea Grass	Lazaro
OZ 4	Revenge	Felipe
OZ 5	Guinea Grass	Lazaro
OZ 6	Tintal	Pucte
OZ 7	Pembroke	Concepcion
OZ 8	Pembroke	Xaibe
OZ 9	Guinea Grass	Lazaro
OZ 10	Guinea Grass	Laxaro
OZ 11	Yaxa	Jolja
OZ 12	Yaxa	Jolja
OZ 13	Puletan	Boom
OZ 14	Puletan	Boom
OZ 15	Yaxa	Yalbac
OZ 16	Yaxa	Yalbac
OZ 17	Yaxa	Yalbac
OZ 18	Bahia	Remate
OZ 19	Pembroke	Puluacax
OZ 20	Pembroke	Xaibe
OZ 21	Revenge	Tok
OZ 22	Altun Ha	Jobo
OZ 23	Guinea Grass	Pixoy
OZ 24	Pembroke	Xaibe
OZ 25	Altun Ha	Jobo
OZ 26	Richardson	Doyle
OZ 27	Richardson	Palmasito
OZ 28	Richardson	Palmasito
OZ 29	Richardson	Palmasito
OZ 30	Tintal	Ycacos
OZ 31	Turneffe	Shipstern
OZ 32	Tintal	Ycacos
OZ 33	Yaxa	Yalbac
OZ 34	Yaxa	Yalbac
OZ 35	Yaxa	Chacluum
OZ 36	Chacalte>Stopper	Xpicilha>Pinol
OZ 37	Vaca	Cuxu
OZ 38	Stopper	Pinol
OZ 39	Ossory	Chiquibul
OZ 40	Stopper	Pinol
OZ 41	Stopper	Pinol
OZ 42	Ossory	Cooma
OZ 43	Ossory	Baldy
OZ 44	Revenge	Felipe
OZ 45	Bahia	Consejo
OZ 46	Pembroke	Louisville
OZ 47	Yaxa	Ramgoat
OZ 48	Tintal	Pucte
OZ 49	Altun Ha	Jobo
OZ 50	Yaxa	Jolja
OZ 51	Pembroke	Louisville
OZ 52	Pembroke	Louisville
OZ 53	Pembroke	Concepcion
OZ 54	Puletan	Crooked Tree
OZ 55	Altun Ha	Jobo
OZ 56	Altun Ha	Jobo

Profile/Pit no.	Suite	Subsuite
OZ 57	Altun Ha	Jobo
OZ 58	Altun Ha	Jobo
OZ 59	Puletan	Crooked Tree
OZ 60	Revenge	Tok
OZ 61	Melinda	Quamina
OZ 62	Melinda	Quamina-Canquin
OZ 63	Melinda	Quamina
OZ 64	Chacalte	Xpicilha
OZ 65	Guinea Cross	Pixoy
OZ 66	Yaxa	Jolja
OZ 67	Yaxa	Ramgoat
OZ 68	Yaxa	Chacluum
OZ 69	Yaxa	Irish Creek
OZ 70	Yaxa	Yalbac
OZ 71	Tintal	Chucum
OZ 72	Guinea Grass	Pixoy
OZ 73	Melinda	Canquin
OZ 74	Ossory	Cooma
OZ 75	Stopper/Chacalte	Pinol/San Lucas
OZ 76	Chacalte	San Lucas
OZ 77	Chacalte	Cabro
OZ 78	Vaca	Cuxu
OZ 79	Stopper	Pinol
OZ 80	Stopper	Pinol
OZ 81	Vaca	Cuxu
OZ 82	Melinda	Sennis
OZ 83	Puletan	Bocotora
OZ 84	Puletan	Bocotora
OZ 85	Tintal	Sibal-Pucte
OZ 86	Ossory	Granodoro
OZ 87	Ossory	Granodoro
OZ 88	Ossory	Machiquila
OZ 89	Altun Ha	Rockstone

Auger Observations

Observation No.	Suite	Subsuite
1	Guinea Grass	Lazaro
2	Pembroke	Louisville
5	Guinea Grass	Pixoy
6	Guinea Grass	Lazaro
8	Guinea Grass	Lazaro
9	Bahia	Consejo
10	Bahia	Consejo
11	Bahia	Consejo
12	Pembroke	Concepcion
13	Pembroke	Concepcion
14	Pembroke	Xaibe
15	Pembroke	Louisville
16	Pembroke	Concepcion
17	Pembroke	Louisville
18	Guinea Grass	Pixoy
19	Guinea Grass	Lazaro
20	Pembroke	Louisville
21	Tintal	Sibal
23	Yaxa	Yalbac
24	Yaxa	Yalbac
25	Yaxa	Yalbac
26	Yaxa	Yalbac
27	Yaxa	Yalbac

Observation No.	Suite	Subsuite
29	Yaxa	Chacluum
30	Yaxa	Yalbac
31	Guinea Grass	Lazaro
32	Guinea Grass	Lazaro
33	Guinea Grass	Lazaro
34	Guinea Grass	Lazaro
37	Guinea Grass	Lazaro
38	Guinea Grass	Lazaro
39	Pembroke	Louisville
40	Pembroke	Louisville
41	Guinea Grass	Lazaro
43	Tintal	Pucte
44	Tintal	Sibal
45	Tintal	Pucte
46	Tintal	Pucte
47	Tintal	Pucte
48	Guinea Grass	Lazaro
49	Pembroke	Louisville
51	Tintal	Pucte
52	Tintal	Pucte
53	Pembroke	Louisville
54	Pembroke/Guinea Grass	Louisville/Lazaro
55	Pembroke	Concepcion
56	Pembroke	Louisville
57	Pembroke	Louisville
58	Pembroke	Louisville
59	Tintal	Pucte
60	Bahia	Remate
61	Pembroke	Louisville
63	Pembroke	Concepcion
64	Pembroke	Louisville
65	Tintal	Pucte
66	Tintal	Pucte
67	Pembroke	Louisville
68	Pembroke	Louisville
69	Pembroke	Concepcion
70	Pembroke	Xaibe
71	Pembroke	Louisville
72	Pembroke	Xaibe
73	Pembroke	Xaibe
75	Pembroke	Xaibe
76	Tintal	Pucte
77	Bahia	Remate
78	Pembroke	Concepcion
79	Bahia	Remate
80	Pembroke	Louisville
81	Pembroke	Louisville
82	Tintal	Sibal
83	Tintal	Pucte
84	Yaxa	Jolja
85	Yaxa	Jolja
86	Yaxa	Jolja
87	Yaxa	Jolja
89	Yaxa	Jolja
90	Yaxa	Jolja
91	Yaxa	Jolja
92	Yaxa	Jolja
93	Yaxa	Jolja
94	Yaxa	Jolja

Observation No.	Suite	Subsuite
95	Yaxa	Jolja
96	Tintal	Chucum
97	Tintal	Chucum
98	Yaxa	Yalbac
99	Yaxa	Yalbac
100	Yaxa	Yalbac
103	Guinea Grass	Pixoy
104	Guinea Grass	Pixoy
105	Guinea Grass	Pixoy
106	Guinea Grass	Lazaro
107	Guinea Grass	Lazaro
108	Yaxa	Yalbac
109	Yaxa	Yalbac
110	Yaxa	Yalbac
111	Guinea Grass	Lazaro
112	Yaxa	Yalbac
113	Guinea Grass	Lazaro
114	Guinea Grass	Pixoy
115	Yaxa	Yalbac
116	Guinea Grass	Lazaro
117	Yaxa	Yalbac
118	Guinea Grass	Lazaro
119	Guinea Grass	Lazaro
120	Puletan	Haciapina
121	Puletan	Haciapina
122	Puletan	Haciapina
123	Guinea Grass	Lazaro
124	Guinea Grass	Lazaro
125	Guinea Grass	Pixoy
126	Guinea Grass	Lazaro
127	Guinea Grass	Pixoy
129	Yaxa	Yalbac
131	Yaxa	Yalbac
132	Tintal	Pucte
133	Tintal	Pucte
134	Yaxa	Yalbac
135	Yaxa	Yalbac
136	Yaxa	Yalbac
137	Tintal	Pucte
138	Yaxa	Yalbac
139	Yaxa	Yalbac
140	Yaxa	Yalbac
141	Puletan	Haciapina
142	Revenge	Tok
143	Revenge	Felipe
144	Yaxa	Yalbac
145	Yaxa	Yalbac
146	Tintal	Pucte
147	Revenge	Felipe
149	Revenge	Felipe
150	Melinda	Sennis
151	Tintal	Pucte
152	Yaxa	Yalbac
153	Yaxa	Yalbac
154	Yaxa	Yalbac
156	Tintal	Sibal
157	Yaxa	Jolja
158	Yaxa	Chacluum
159	Yaxa	Yalbac
160	Yaxa	Yalbac

Observation No.	Suite	Subsuite
161	Yaxa	Jolja
162	Yaxa	Jolja
163	Yaxa	Yalbac
164	Yaxa	Jolja
165	Yaxa	Yalbac
166	Yaxa	Chacluum
167	Yaxa	Yalbac
168	Yaxa	Chacluum
169	Yaxa	Chacluum
170	Yaxa	Yalbac
171	Yaxa	Yalbac
172	Melinda	Pasmore
173	Tintal	Pucte
174	Tintal	Pucte
175	Guinea Grass	Lazaro
176	Guinea Grass	Lazaro
177	Guinea Grass	Lazaro
178	Tintal	Sibal
179	Tintal	Pucte
180	Guinea Grass	Lazaro
181	Guinea Grass	Lazaro
182	Guinea Grass	Lazaro
183	Bahia	Remate
184	Bahia	Remate
185	Bahia	Remate
187	Pembroke	Louisville
188	Pembroke	Xaibe
189	Pembroke	Xaibe
190	Bahia	Remate
191	Bahia	Remate
192	Tintal	Pucte
193	Bahia	Remate
194	Tintal	Sibal
195	Tintal	Sibal
196	Pembroke	Puluacax
197	Pembroke	Louisville
198	Altun Ha	Jobo
199	Pembroke	Puluacax
200	Bahia	Remate
202	Tintal	Pucte
203	Bahia	Remate
204	Pembroke	Xaibe
205	Pembroke	Xaibe
206	Bahia	Remate
207	Bahia	Remate
208	Pembroke	Xaibe
209	Bahia	Remate
210	Pembroke	Xaibe
211	Pembroke	Xaibe
212	Bahia	Remate
213	Bahia	Remate
214	Pembroke	Xaibe
215	Pembroke	Puluacax
216	Bahia	Remate
217	Pembroke	Xaibe
218	Guinea Grass	Lazaro
219	Guinea Grass	Pixoy
220	Guinea Grass	Pixoy
221	Revenge	Tok
222	Revenge	Tok

Observation No.	Suite	Subsuite
223	Guinea Grass	Lazaro
224	Altun Ha	Jobo
225	Revenge	Felipe
226	Revenge	Tok
227	Revenge	Tok
228	Revenge	Tok
229	Revenge	Tok
230	Revenge	Tok
231	Puletan	Haciapina
232	Revenge	Tok
233	Altun Ha	Jobo
234	Altun Ha	Jobo
235	Altun Ha	Rockstone
236	Altun Ha	Jobo
237	Altun Ha	Jobo
238	Altun Ha	Jobo
239	Altun Ha	Jobo
240	Altun Ha	Jobo
241	Altun Ha	Rockstone
242	Altun Ha	Jobo
243	Yaxa	Yalbac
244	Altun Ha	Rockstone
245	Altun Ha	Jobo
246	Altun Ha	Jobo
247	Revenge	Tok
248	Guinea Grass	Pixoy
249	Altun Ha	Jobo
250	Altun Ha	Jobo
251	Tintal	Pucte
252	Guinea Grass	Pixoy
253	Tintal	Pucte
254	Revenge	Tok
255	Guinea Grass	Pixoy
257	Revenge	Tok
258	Revenge	Tok
259	Altun Ha	Rockstone
260	Altun Ha	Rockstone
261	Altun Ha	Jobo
262	Altun Ha	Jobo
263	Tintal	Pucte
264	Pembroke	Louisville
265	Pembroke	Louisville
266	Pembroke	Louisville
267	Altun Ha	Jobo
268	Altun Ha	Jobo
269	Altun Ha	Jobo
270	Yaxa	Yalbac
271	Altun Ha	Jobo
272	Altun Ha	Jobo
273	Altun Ha/Guinea Grass	Jobo/Pixoy
275	Yaxa	Yalbac
276	Yaxa	Yalbac
277	Revenge	Tok
278	Altun Ha	Jobo
279	Altun Ha	Jobo
280	Altun Ha	Jobo
281	Pembroke	Puluacax
282	Altun Ha	Rockstone
284	Revenge	Tok
285	Altun Ha	Jobo

Observation No.	Suite	Subsuite
286	Guinea Grass	Pixoy
287	Guinea Grass	Lazaro
288	Pembroke	Xaibe
289	Bahia	Remate
290	Tintal	Pucte
291	Pembroke	Xaibe
292	Pembroke	Xaibe
293	Tintal	Pucte
294	Bahia	Remate
296	Pembroke	Puluacax
297	Bahia	Remate
298	Bahia	Remate
299	Pembroke	Xaibe
300	Tintal	Pucte
301	Pembroke	Xaibe
302	Melinda	Canquin
303	Melinda	Canquin
304	Melinda	Quamina
305	Melinda	Canquin
306	Chacalte	Cabro
307	Chacalte	Xpicilha
308	Melinda	Canquin
309	Melinda	Canquin
310	Melinda	Quamina
311	Melinda	Canquin
312	Melinda	Canquin
313	Melinda	Quamina
314	Melinda	Canquin
315	Melinda	Quamina
316	Melinda	Quamina
317	Melinda	Canquin
318	Puletan	Boom
319	Altun Ha	Rockstone
320	Puletan	Boom
321	Puletan	Crooked Tree
322	Puletan	Crooked Tree
323	Altun Ha	Jobo
324	Altun Ha	Jobo
326	Revenge	Tok
327	Altun Ha	Rockstone
328	Altun Ha	Jobo
329	Revenge	Tok
330	Puletan	Crooked Tree
331	Altun Ha	Jobo
332	Puletan	Crooked Tree
333	Yaxa	Yalbac
334	Puletan	Boom
335	Puletan	Boom
336	Altun Ha	Jobo
337	Altun Ha	Jobo
338	Altun Ha	Jobo
339	Altun Ha	Rockstone
340	Altun Ha	Rockstone
342	Richardson	Palmasito
343	Richardson	Palmasito
344	Richardson	Palmasito
345	Richardson	Palmasito-Ramos
346	Richardson	Palmasito
347	Richardson	Palmasito
348	Richardson	Doyle

Observation No.	Suite	Subsuite
349	Richardson	Ramos
350	Richardson	Palmasito
353	Richardson	Palmasito
354	Richardson	Palmasito
355	Richardson	Palmasito
356	Richardson	Ramos
357	Richardson	Palmasito
358	Richardson	Palmasito
359	Richardson	Palmasito
361	Turneffe	Shipstern
362	Turneffe	Shipstern
363	Turneffe	Shipstern
365	Turneffe	Ambergris
366	Tintal	Ycacos
367	Turneffe	Shipstern
368	Tintal	Ycacos
369	Turneffe	Shipstern
370	Turneffe	Ambergris
371	Tintal	Ycacos
372	Turneffe	Shipstern
373	Turneffe	Shipstern
374	Turneffe	Shipstern
375	Turneffe	Shipstern
376	Tintal > Turneffe	Ycacos > Shipstern
377	Turneffe	Shipstern
379	Tintal	Ycacos
380	Turneffe	Shipstern
381	Turneffe	Shipstern
382	Tintal	Sibal
383	Yaxa	Yalbac
384	Yaxa	Yalbac
385	Yaxa	Yalbac
386	Tintal	Pucte
387	Yaxa	Yalbac
388	Tintal	Pucte
389	Yaxa	Yalbac
390	Yaxa	Yalbac
391	Yaxa	Yalbac
392	Yaxa	Yalbac
393	Yaxa	Yalbac
394	Yaxa	Yalbac
395	Yaxa	Yalbac
396	Tintal	Pucte
398	Yaxa	Yalbac
399	Yaxa	Yalbac
400	Yaxa	Yalbac
401	Yaxa	Yalbac
402	Yaxa	Yalbac
403	Yaxa	Yalbac
404	Yaxa	Yalbac
405	Yaxa	Yalbac
406	Yaxa	Yalbac
407	Yaxa	Yalbac
408	Yaxa	Yalbac
409	Yaxa	Yalbac
411	Yaxa	Yalbac
412	Yaxa	Yalbac
413	Yaxa	Chacluum
414	Yaxa	Ramgoat
415	Yaxa	Yalbac

Observation No.	Suite	Subsuite
416	Yaxa	Ramgoat
417	Yaxa	Chacluum
418	Yaxa	Ramgoat
419	Yaxa	Ramgoat
420	Yaxa	Yalbac
421	Yaxa	Chacluum
423	Yaxa	Yalbac
424	Yaxa	Yalbac
425	Yaxa	Yalbac
426	Yaxa	Yalbac
427	Yaxa	Ramgoat
428	Yaxa	Yalbac
429	Yaxa	Yalbac
431	Stopper	Pinol
432	Stopper	Pinol
433	Stopper	Pinol
434	Stopper	Pinol
435	Stopper	Pinol
436	Stopper	Pinol
437	Stopper	Pinol
439	Vaca	Cuxu
440	Vaca	Cuxu
441	Vaca	Cuxu
443	Vaca	Cuxu
444	Vaca	Cuxu
445	Stopper	Pinol
446	Stopper	Pinol
447	Stopper	Pinol
448	Ossory	Cooma
449	Stopper	Pinol
450	Stopper/Ossory	Pinol/Cooma
451	Stopper	Pinol
452	Stopper/Ossory	Pinol/Cooma
454	Stopper	Pinol
456	Ossory	Cooma
457	Ossory	Cooma
458 (a)	Ossory	Cooma
458 (b)	Stopper	Pinol
460	Stopper	Pinol
461	Stopper	Pinol
462	Stopper	Pinol
463	Stopper	Pinol
464	Stopper	Pinol
465	Stopper	Pinol
466	Ossory	Cooma
467	Vaca	Cuxu
468	Stopper	Pinol
469	Vaca	Cuxu
471	Ossory	Cooma
472	Ossory	Cooma
473	Ossory	Cooma
474	Ossory	Cooma
475	Ossory	Cooma
476	Ossory	Baldy
477	Ossory	Baldy
478	Ossory	Baldy
479	Ossory	Baldy
480	Vaca	Cuxu
481	Vaca	Cuxu
482	Vaca	Cuxu

Observation No.	Suite	Subsuite
483	Vaca	Cuxu
484	Vaca	Cuxu
485	Vaca	Cuxu
486	Vaca	Cuxu
487	Vaca	Cuxu
488	Vaca	Cuxu
489	Vaca	Cuxu
500	Yaxa	Yalbac
501	Yaxa	Yalbac
502	Yaxa	Yalbac
503	Yaxa	Yalbac
504	Yaxa	Yalbac
505	Tintal	Pucte
506	Yaxa	Yalbac
507	Yaxa	Yalbac
508	Yaxa	Yalbac
509	Yaxa	Yalbac
510	Yaxa	Yalbac
511	Yaxa	Yalbac
512	Yaxa	Yalbac
513	Yaxa	Yalbac
514	Guinea Grass	Pixoy
515	Tintal	Pucte
517	Guinea Grass	Lazaro
518	Yaxa	Yalbac
519	Yaxa	Yalbac
520	Tintal	Pucte
521	Yaxa	Yalbac
522	Yaxa/Guinea Grass	Yalbac/Lazaro
524	Yaxa	Yalbac
525	Guinea Grass	Lazaro
526	Guinea Grass/Revenge	Lazaro/Felipe
527	Revenge	Felipe
528	Revenge	Felipe
529	Revenge	Felipe
531	Revenge	Felipe
532	Yaxa	Yalbac
533	Yaxa	Yalbac
534	Bahia	Consejo
535	Bahia	Consejo
537	Bahia	Consejo
538	Tintal	Sibal
539	Bahia	Consejo
540	Bahia	Consejo
541	Bahia	Consejo
542	Pembroke	Xaibe
543	Bahia	Remate
544	Bahia	Consejo
545	Bahia	Consejo
546	Bahia	Remate
547	Pembroke	Louisville
548	Bahia	Consejo
549	Bahia	Consejo
550	Pembroke	Xaibe
551	Bahia	Remate
552	Pembroke	Louisville
553	Pembroke	Louisville
554	Bahia	Remate
555	Pembroke	Xaibe
556	Pembroke	Louisville

Observation No.	Suite	Subsuite
557	Pembroke	Xaibe
558	Pembroke	Louisville
559	Pembroke	Louisville
560	Pembroke	Louisville
561	Pembroke	Louisville
562	Pembroke	Louisville
563	Pembroke	Louisville
564	Pembroke	Louisville
565	Pembroke	Louisville
566	Pembroke	Louisville
567	Pembroke	Louisville
569	Guinea Grass	Pixoy
570	Guinea Grass	Lazaro
571	Guinea Grass	Lazaro
572	Yaxa	Yalbac
573	Yaxa	Yalbac
574	Guinea Grass	Lazaro
575	Revenge	Felipe
576	Yaxa	Yalbac
577	Guinea Grass	Pixoy
578	Guinea Grass	Lazaro
579	Yaxa	Ramgoat
580	Yaxa	Chacluum
581	Yaxa	Ramgoat
582	Yaxa	Ramgoat
583	Yaxa	Ramgoat
584	Yaxa	Yalbac
585	Yaxa	Yalbac
586	Yaxa	Yalbac
587	Yaxa	Yalbac
588	Tintal	Pucte
589	Tintal	Pucte
590	Tintal	Pucte
591	Yaxa	Yalbac
592	Yaxa	Yalbac
593	Yaxa	Yalbac
594	Yaxa	Yalbac
595	Yaxa	Chacluum
596	Yaxa	Ramgoat
597	Tintal	Chucum
598	Tintal	Chucum
599	Yaxa	Ramgoat
601	Altun Ha	Rockstone
602	Altun Ha	Jobo
603	Altun Ha	Jobo
604	Altun Ha	Jobo
606	Pembroke/Altun Ha	Puluacax/Jobo
607	Altun Ha	Jobo
608	Pembroke	Puluacax
609	Altun Ha	Jobo
610	Pembroke	Xaibe
611	Tintal	Pucte
612	Pembroke	Xaibe
613	Puletan	Boom
614	Puletan	Crooked Tree
615	Melinda	Monkey River
616	Puletan	Boom
617	Puletan	Haciapina
618	Puletan	Boom
619	Puletan	Boom

Observation No.	Suite	Subsuite
620	Puletan	Boom
621	Melinda	Sennis
622	Puletan	Boom
623	Puletan	Boom
624	Revenge	Tok
625	Puletan	Boom
626	Puletan	Boom
627	Puletan	Crooked Tree
628	Yaxa	Jolja
629	Yaxa	Yalbac
630	Yaxa	Yalbac
631	Yaxa	Yalbac
632	Yaxa	Yalbac
634	Pembroke	Louisville
635	Pembroke	Louisville
637	Pembroke	Louisville
638	Pembroke	Louisville
639	Pembroke	Louisville
640	Pembroke	Louisville
642	Pembroke	Louisville
643	Pembroke	Louisville
644	Pembroke	Louisville
645	Pembroke	Louisville
646	Pembroke	Louisville
647	Pembroke	Concepcion
648	Pembroke	Louisville
649	Tintal	Pucte
650	Pembroke	Louisville
651	Pembroke	Concepcion
652	Pembroke	Concepcion
653	Pembroke	Louisville
654	Pembroke	Louisville
655	Pembroke	Concepcion
656	Pembroke	Louisville
658	Bahia	Remate
659	Pembroke	Louisville
660	Bahia	Remate
661	Pembroke	Louisville
662	Bahia	Remate
663	Bahia	Remate
664	Tintal	Sibal
665	Tintal	Pucte
666	Pembroke	Louisville
667	Tintal	Pucte
668	Pembroke	Louisville
669	Pembroke	Louisville
670	Pembroke	Louisville
671	Pembroke	Louisville
672	Pembroke	Louisville
673	Tintal	Pucte
674	Pembroke	Concepcion
675	Puletan	Crooked Tree
676	Puletan	Crooked Tree
677	Puletan	Crooked Tree
678	Puletan	Crooked Tree
680	Puletan	Crooked Tree
681	Puletan	Crooked Tree
682	Puletan	Crooked Tree
683	Revenge	Tok
685	Puletan	Boom

Observation No.	Suite	Subsuite
686	Melinda	Sennis
687	Revenge	Tok
688	Tintal	Sibal
689	Puletan	Crooked Tree
690	Puletan	Crooked Tree
691	Puletan	Crooked Tree
692	Puletan	Boom
693	Puletan	Crooked Tree
694	Revenge	Tok
695	Puletan	Boom
696	Altun Ha	Rockstone
697	Altun Ha	Jobo
698	Altun Ha	Jobo
700	Altun Ha	Jobo
702	Altun Ha	Jobo
703	Altun Ha	Jobo
704	Altun Ha	Jobo
705	Altun Ha	Jobo
706	Altun Ha	Jobo
707	Altun Ha	Rockstone
708	Altun Ha	Jobo
710	Altun Ha	Jobo
711	Altun Ha	Jobo
712	Altun Ha	Jobo
713	Altun Ha	Jobo
714	Revenge	Tok
716	Altun Ha	Rockstone
717	Tintal	Sibal
718	Revenge	Tok
719	Puletan	Crooked Tree
722	Revenge	Tok
723	Revenge	Tok
724	Puletan	Boom
725	Puletan	Haciapina
726	Revenge	Tok
727	Revenge	Tok
728	Revenge	Tok
729	Tintal	Pucte
730	Pembroke	Louisville
731	Guinea Grass	Lazaro
732	Melinda	Canquin
733	Melinda	Canquin
734	Melinda	Canquin
735	Melinda	Canquin
737	Melinda	Canquin
738	Melinda	Canquin
739	Melinda	Quamina
740	Melinda	Quamina
741	Melinda	Quamina
743	Melinda	Quamina
744	Melinda	Quamina
745	Melinda	Quamina
746	Melinda	Monkey River
747	Melinda	Monkey River
748	Melinda	Canquin
749	Melinda	Canquin
750	Melinda	Canquin
752	Chacalte	Cabro
753	Chacalte	Cabro
754	Melinda	Canquin

Observation No.	Suite	Subsuite
755	Melinda	Quamina
756	Melinda	Quamina
757	Melinda	Canquin
758	Chacalte/Ossory	
759	Chacalte	San Lucas
760	Chacalte/Ossory	
761	Chacalte/Stopper	
762	Chacalte/Ossory	
763	Ossory	Dancing Pool
764	Chacalte	Xpicilha
765	Chacalte	San Lucas
766	Chacalte	Cabro
768	Melinda	Canquin
769	Melinda	Monkey River
770	Melinda	Canquin
771	Ossory	Curassow
772	Melinda	Canquin
773	Melinda	Canquin
774	Melinda	Monkey River
775	Melinda	Monkey River
776	Melinda	Canquin
777	Melinda	Canquin
778	Melinda	Canquin
779	Altun Ha	Jobo
780	Guinea Grass	Lazaro
781	Guinea Grass	Lazaro
782	Guinea Grass	Lazaro
783	Tintal	Pucte
784	Pembroke	Xaibe
785	Pembroke	Xaibe
786	Pembroke	Xaibe
787	Bahia	Remate
788	Pembroke	Xaibe
789	Bahia	Consejo
790	Bahia	Consejo
791	Pembroke	Xaibe
792	Altun Ha	Jobo
793	Altun Ha	Jobo
794	Altun Ha	Jobo
795	Altun Ha	Jobo
796	Altun Ha	Jobo
797	Guinea Grass	Lazaro
798	Guinea Grass	Lazaro
799	Revenge	Felipe
800	Puletan	Crooked Tree
802	Guinea Grass	Pixoy
803	Revenge	Felipe
804	Revenge	Felipe
805	Revenge	Felipe
806	Puletan	Crooked Tree
807	Puletan	Crooked Tree
808	Puletan	Crooked Tree
810	Puletan	Boom
811	Revenge	Tok
812	Yaxa	Jolja
813	Yaxa	Jolja
814	Yaxa	Jolja
816	Yaxa	Jolja
817	Yaxa	Jolja
818	Yaxa	Jolja

Observation No.	Suite	Subsuite
819	Yaxa	Jolja
820	Yaxa	Jolja
821	Yaxa	Jolja
822	Yaxa	Jolja
823	Yaxa	Jolja
824	Yaxa	Yalbac
825	Yaxa	Ramgoat
826	Tintal	Chucum
828	Yaxa	Chacluum
830	Yaxa	Chacluum
831	Yaxa	Ramgoat
832	Yaxa	Ramgoat
833	Yaxa	Ramgoat
834	Yaxa	Yalbac
836	Tintal	Chucum
837	Yaxa	Ramgoat
838	Puletan	Boom
839	Revenge	Tok
840	Revenge	Tok
841	Revenge	Tok
842	Puletan	Buttonwood
843	Revenge	Tok
844	Revenge	Tok
845	Altun Ha	Rockstone
846	Altun Ha	Rockstone
847	Altun Ha	Rockstone
848	Altun Ha	Jobo
849	Tintal	Ycacos
850	Tintal	Sibal
851	Revenge	Tok
852	Altun Ha	Rockstone
853	Altun Ha	Jobo
854	Tintal	Chucum
855	Tintal	Chucum
856	Yaxa	Ramgoat
857	Yaxa	Yalbac
858	Yaxa	Yalbac
859	Yaxa	Ramgoat
860	Yaxa	Ramgoat
861	Yaxa	Chacluum
862	Tintal	Chucum
863	Yaxa	Ramgoat
864	Guinea Grass	Lazaro
865	Guinea Grass	Lazaro
866	Guinea Grass	Lazaro
867	Guinea Grass	Lazaro
868	Guinea Grass	Pixoy
869	Guinea Grass	Lazaro
870	Yaxa	Yalbac
871	Yaxa	Yalbac
872	Yaxa	Yalbac
873	Yaxa	Yalbac
874	Yaxa	Yalbac
875	Altun Ha	Jobo
876	Yaxa	Yalbac
877	Yaxa	Yalbac
878	Yaxa	Yalbac
880	Yaxa	Yalbac
881	Yaxa	Yalbac
882	Revenge	Felipe

Observation No.	Suite	Subsuite
883	Revenge	Tok
884	Revenge	Tok
885	Revenge	Felipe
886	Revenge	Felipe
887	Puletan	Crooked Tree
888	Revenge	Felipe
890	Guinea Grass	Pixoy
891	Puletan	Boom
892	Revenge	Tok
893	Puletan	Boom
894	Puletan	Boom
895	Puletan	Crooked Tree
896	Puletan	Crooked Tree
897	Puletan	Boom
898	Revenge	Felipe
899	Puletan	Crooked Tree
900	Puletan	Crooked Tree
901	Puletan	Haciapina
902	Puletan	Crooked Tree
903	Puletan	Crooked Tree
904	Puletan	Crooked Tree
905	Puletan	Crooked Tree
906	Puletan	Crooked Tree
907	Puletan	Crooked Tree
908	Melinda	Sennis
909	Puletan	Haciapina
910	Puletan	Haciapina
912	Stopper	Pinol
913	Stopper	Pinol
914	Stopper	Pinol
915 (a)	Ossory	Cooma
915 (b)	Stopper	Pinol
916	Stopper	Pinol
917	Stopper	Pinol
918	Stopper	Pinol
919	Ossory	Cooma
921	Ossory	Cooma – Baldy
922	Ossory	Cooma
923	Stopper	Pinol
924	Stopper	Pinol
925	Ossory	Cooma
926	Ossory	Cooma
928	Melinda	Monkey River – Canquin
929	Stopper	Pinol
930	Vaca	Cuxu
931	Ossory – Stopper	Cooma – Pinol
932	Stopper	Pinol
933	Stopper	Pinol
934	Stopper	Pinol
935	Stopper	Pinol
936	Stopper	Pinol
937	Vaca	Cuxu
938	Stopper	Pinol
939	Stopper	Pinol
940	Ossory	Cooma
941	Vaca	Cuxu
942	Ossory/Stopper	Cooma/Pinol
943	Ossory	Cooma
944	Ossory	Cooma
945	Vaca	Cuxu

Observation No.	Suite	Subsuite
947	Vaca	Cuxu
948	Stopper – ?Ossory	Pinol – ?Cooma
949	Chacalte	San Lucas
950	Chacalte	Cabro
951 (a)	Chacalte	Cabro
951 (b)	Vaca	Cuxu
952	Chacalte	Xpicilha
953	Chacalte	Cabro – Xpicilha
954	Chacalte	San Lucas
955	Chacalte	Xpicilha
956	Chacalte	Xpicilha
957	Chacalte	Xpicilha
958	Chacalte	Cabro
959	Ossory	Granodoro
960	Ossory	Granodoro
961	Ossory	Granodoro
962	Ossory	Granodoro
963	Ossory	Granodoro
964	Ossory	Granodoro
965	Ossory	Granodoro
966	Chacalte	Xpicilha
967	Ossory	Cooma
968	Ossory	Cooma
969	Ossory	Cooma
970	Chacalte	San Lucas
971	Vaca	Cuxu
972	Vaca	Cuxu
974	Chacalte	Cabro
975	Chacalte	Xpicilha
976	Melinda	Canquin
977	Chacalte	Cabro
978	Ossory	Granodoro
979	Chacalte – Ossory	San Lucas – Machiquila
980	Ossory	Granodoro
981	Ossory	Machiquila
982	Chacalte	Xpicilha
983	Ossory	Machiquila
984	Chacalte	Cabro
985	Ossory	Machiquila
986	Chacalte	Cabro
987	Vaca	Cuxu
991	Stopper	Pinol
993 (a)	Stopper – Chacalte	Pinol – San Lucas
993 (b)	Stopper	Pinol
993 (c)	Vaca	Cuxu
994	Ossory	Cooma
995	Ossory	Cooma
996	Vaca	Cuxu
997	Stopper	Pinol
998	Stopper	Pinol
999	Ossory	Cooma
1000	Ossory	Cooma
1001	Stopper	Pinol
1002	Ossory	Cooma
1003	Stopper	Pinol
1005	Stopper	Pinol
1006	Vaca	Cuxu
1007	Vaca	Cuxu
1008	Vaca	Cuxu
1009	Vaca	Cuxu

Observation No.	Suite	Subsuite
1010	Vaca	Cuxu
1012	Chacalte	Xpicilha
1013	Vaca	Cuxu
1014	Vaca	Cuxu
1015	Vaca	Cuxu
1016	Vaca	Cuxu
1017	Vaca	Cuxu
1018	Vaca	Cuxu
1019	Vaca – Chacalte	Cuxu – San Lucas
1020	Pembroke	Louisville
1021	Pembroke	Louisville
1022	Pembroke	Concepcion
1023	Pembroke	Xaibe
1024 (a)	Pembroke	Xaibe
1024 (b)	Bahia	Remate
1025	Ossory	Canquin
1026	Melinda	Sennis
1027	?Melinda	?Canquin
1030	Puletan	Bocotora
1032	Puletan	Bocotora
1033	Puletan	Bocotora – Crooked Tree
1034	Puletan	Bocotora
1035	Puletan	Bocotora
1036	Puletan	Bocotora
1038	Yaxa	Yalbac
1039	Yaxa	Yalbac
1040	Yaxa	Yalbac
1041	Yaxa	Yalbac
1042	Yaxa	Yalbac
1043	Yaxa	Yalbac
1044	Yaxa	Yalbac
1045	Yaxa	Yalbac
1046	Yaxa	Yalbac
1047	Yaxa	Yalbac
1048	Yaxa	Yalbac
1049	Yaxa	Yalbac – Chacluum
1050	Yaxa	Yalbac
1051	Yaxa	Yalbac
1052	Yaxa	Yalbac
1053	Yaxa	Yalbac
1054	Yaxa	Yalbac
1055	Yaxa	Yalbac
1056	Yaxa	Yalbac
1057	Yaxa	Yalbac
1058	Yaxa	Yalbac
1059	Yaxa	Yalbac
1060	Melinda	Pasmore
1061	Yaxa	Yalbac
1062	Yaxa	Yalbac
1063	Yaxa	Yalbac
1064	Yaxa	Yalbac
1065	Yaxa	Yalbac
1066	Yaxa	Yalbac
1067	Melinda	Pasmore
1068	Yaxa	Yalbac
1069	Yaxa	Yalbac
1070	Yaxa	Irish Creek
1071	Yaxa	Yalbac
1072	Yaxa	Yalbac – Chacluum
1073	Yaxa	Chacluum

Observation No.	Suite	Subsuite
1074	Yaxa	Irish Creek
1075	Yaxa	Ramgoat
1076	Yaxa	Irish Creek > Ramgoat
1077	Yaxa	Chacluum
1078	Yaxa	Irish Creek
1079	Yaxa	?Chacluum
1080	Yaxa	Chacluum
1081	Yaxa	Chacluum
1082	Yaxa	Irish Creek
1083	Yaxa	?Irish Creek
1084	Guinea Grass	Pixoy
1085	Guinea Grass	Pixoy
1086	Guinea Grass	Pixoy
1087	Pembroke	Puluacax
1088	Pembroke	Puluacax
1089	Pembroke	Louisville
1090	Pembroke	Louisville
1091	Pembroke	Xaibe
1092	Pembroke	Xaibe
1094	Ossory	Granodoro
1096	Altun Ha	Rockstone

/ = overlying

APPENDIX 5: VEGETATION GLOSSARY

Botanical name	Local names
Acacia costaricensis Schenck	cockspur
Acacia dolichostachya Blake	wild tamarind
Acacia glomerosa Benth.	white tamarind
Acacia spp.	white tamarind
Acoelorraphe wrightii (Griseb.) Wendl.	palmetto
Acosmium panamensis (Benth.) Yakoul	billy webb
Alibertia edulis (L. Rich) A. Rich	wild guava
Alseis yucatanensis Standl.	wild mammee
Alsophila mysuroides Leibm.	tree fern
Amyris belizensis Lundell	waika palm
Andira inermis HBK.	red cabbage bark
Anona sp.	wild custard apple
Aspidosperma megalocarpon Muell. Arg.	mylady
Astrocaryum mexicanum Liebm.	spiny palm, waree cohune
Astroneum graveolens Jacq.	glassywood, palo mulatto, jobillo
Avicennia nitida Jacq.	black mangrove
Belotia campbellii Sprague	narrowleaf moho
Bernadia interrupta (Schlecht.) Muell.	waika ribbon
Bernoullia flammea Oliver	red mapola
Bombax ellipticum HBK.	white mapola
Brosimum alicastrum Swartz	breadnut, ramón
Bucida buceras L.	pucte, northern bullet tree
Bulbostylus paradoxica	shaving brush sedge
Bursera simaruba (L.) Sarg.	red gombolimbo
Byrsonima crassifolia (L.) Hemsl.	craboo
Calocarpum mammosum (L.) Pierre	mammey sapote
Calophyllum brasiliense Camb.	santa maria
Calyptranthes spp.	wild orange, naranjo
Cameraria belizensis Standl.	white poisonwood
Carapa guianensis Aubl.	bastard mahogany, crabwood
Cassia grandis L.	bookut
Castilla elastica Sesse	wild rubber
Cecropia pelata Gris.	trumpet tree
Cedrela mexicana Roem.	cedar
Ceiba pentandra (L.) Gaertn.	cotton tree
Celtis schippii Standl.	female bullhoof
Cestrum megalophyllum Dunal	
Chlorophora tinctoria (L.) Guag.	fustic
Chrysobalancus icaco L.	cocoplum
Chrysophyllum oliviforme L.	wild star apple
Clusia utilis Blake	matapalo
Coccoloba spp.	wild grape, bob
Coccoloba uvifera (L.) Jacq.	sea grape
Composoneura sprucei (A. Dc.) Warb	shrivel stick
Concocarpus erecta L.	buttonwood mangrove
Cordia alliodora (Ruiz & Paron) Cham.	salmwood, bohom
Cordia dodecandra DC.	ziricote
Crescentia cujete L.	calabash
Croton schiedeanus Schlect.	wild cinnamon
Croton pyramidalis Donn. SM.	pu pu tek
Crysophila argentea Bartlett	bayleaf palm
Curatella americana L.	sandpaper tree
Dalbergia stevensonii Standl.	rosewood

Botanical name	Local names
Dendropanax arboreus (L.) Decne. & Planch.	white gombolimbo
Desmoncus schippi Burrett	basket tie-tie
Dialium guianensis (Aubl.) Steud	ironwood, tamarindo
Dicranopteris pectinata Wild.	tigerbush fern
Dieffenbachia seguina (L.) Schott	dumb cane
Dipholis stevensonii Standl.	faisan
Drypetes brownii Standl.	male bullhoof
Enterolobium cyclocarpus (Jacq.) Griseb.	tubroos, guanacaste
Erythroxylon areolatum L.	redwood
Eugenia spp.	blossomberry, sikiya caimito
Euterpe olearacea Mart.	mountain cabbage palm
Ficus spp.	fig, tsutz
Gilbertia concinna Standl.	white gombolimbo
Guadua spinosa (Swallen) McClure	bamboo
Guarea excelsa HBK.	cramantee
Guarea glabra Vahl.	wild orange
Guazuma ulmifolia Lam.	caulote, bay cedar, pixoy
Guettarda combsii Urban	glassywood
Haematoxylon campechianum L.	logwood, tinta
Heliocarpus donnell-smithii Rose	broadleaf moho
Hirtella americana L.	pigeon plum
Hirtella triandra Sw.	caca te
Hymenaea courbaril L.	wild locust
Hyperbaena winzerlingii Standl.	knock-me-back
Ilex panamensis Standl.	dogwood
Inga edulis Mart.	bribri
Krugiodendron ferreum (Vahl.) Urban	axemaster
Laguncularia racemosa (L.) Gaertn.	white mangrove
Licania platypus (Hemsl.) Fritsch	monkey apple
Licaria peckii (Johnst.) Kosterm.	timbersweet
Lonchocarpus castilloi Standl.	black cabbagebark, manchich
Lucuma belizensis Standl.	silion
Mammea americana L.	mammey apple
Manicaria saccifera Gaertn.	comfray palm
Manilkara chicle (Pitto) Gilly	chiquibul, chicle
Manilkara zapota (L.) van Royen	sapodilla, sapote
Metopium brownei (Jacq.) Urban	black poisonwood, chechem
Miconia habrolepsis Standl.	maya
Mosquitoxylum jamaicense Krug. & Urban	ridge redwood, bastard mahogany
Mouriria sp.	jug
Myrica cerifera L.	teabox
Myroxylon balsamum var. *pereirae* (Royle) Harms.	balsam
Nectandra globosa (Aulb.) Mez.	timbersweet, aguacatillo
Ocotea sp.	timbersweet, aquacatillo
Ochroma limonensis Rowlee	balsa, polak
Orbignya cohune (Mart.) Dahlgren	cohune palm, corozo
Oreopanax liebmannii Marchal	yaxyulup
Ormosia toledoana Standl.	hormiga
Ormosia isthmensis Standl.	hormiga
Pachira aquatica Aubl.	provision tree
Paurotis wrightii (Griseb. & Wendl.) Britt.	palmetto
Persea americana Mill.	aguacatillo, wild pear
Pimenta officinalis Lindl.	allspice, pimento

Botanical name	Local names
Pinus caribaea Morelet var. *hondurensis* Barr & Golf	caribbean pine
Piper auritum	cowfoot
Pinus patula Schiede and Deppe ssp. *tecunumanii* Equiluz & Perry	occarpa pine
Pithecellobium albicans (Kunth.) Benth.	chucum
Pithecellobium arboreum (L.) Urban	barba jolote
Pithecellobium sp.	john crow wood
Podocarpus guatemalensis Standl.	cypress
Poulsenia armata (Miq.) Standl.	chi chi caste
Poulsenia sp.	white breadnut
Pouteria amygdalina (Standl.) Baehni.	red silion, silly young
Pouteria campechiana (HBK.) Baehni	mamey ciruela
Pouteria durlandii (Standl.) Baehni.	plantain stick
Pouteria lundelli (Standl.) L. Wms.	
Pouteria izabalensis (Standl.) Baehni.	red silion, silly young
Protium copal Schlect. & Cham. Engl.	copal
Pseudolmedia oxyphyllaria Donn. Smith	cherry
Pseudolmedia spuria (Swartz) Griseb.	cherry
Psidium guajava L.	wild guava, guayabillo
Pterocarpus officinalis Jacq.	swamp kaway, palo de sangre
Quararibea sp.	batidos
Quercus hondurensis Trelease	oak
Quercus oleoides Schlect. & Cham.	oak
Quercus peduncularis Nee var *sublanosa* (Trel.) C. Muller	oak
Quercus sapotaefolia Liebm.	oak
Rehdera penninervia Standl. & Moldenke	hinge-hinge
Rheedia intermedia Pitt	limoncillo, corajel
Rheedia edulis Triana & Planch.	waika plum
Rhizophora mangle L.	red mangrove
Rinorea spp.	wild coffee
Roystonia oleracea (Mart.) Cook	cabbage palm
Sabal mauritiiformis (Karst.) Griseb. & Wendl.	bayleaf palm
Sabal morrisiana Bartlett	botan palm
Schippia concolor Burrett	palmetto
Schizolobium parahybum (Vell.) Blake	quamwood
Scleria bracteata Cav.	cutting grass
Sebastiania adenophora Pax & Hoffm.	ridge white poisonwood
Simaruba glauca DC	negrito
Sloanea eriostemon Sprague & Riley	wild atta
Spondias mombin L.	hogplum, jobo
Stemmadenia obovata Schum.	cojeton
Swartzia sp.	bastard rosewood
Sweetia panamensis Benth.	billy webb
Swietenia macrophylla King	mahogany
Symphonia globulifera L.	waika chewstick
Tabebuia crysantha (Jacq.) Nich.	cortéz
Tabebuia pentaphylla (L.) Hemsl.	mayflower, roble
Tapirira macrophylla Lundell	southern wild mahogany
Tetragastris stevensonii Standl.	carbón
Terminalia obovata (R&P.) Standl.	nargusta
Thevetia gaumeri Hemsl.	cojeton
Thrinax wendlandiana Beccari	chit
Tovomita nicaraguensis (Oerst.) L. Wms.	softstick
Trema floridana Britton	wild bay cedar
Trophis racemosa (L.) Urban	breadnut
Varairea lundellii (Standl.) Killip	bitterwood

Botanical name	Local names
Virola brachycarpa Standl.	bastard banak
Virola koschnyi Warb.	banak
Vismia ferruginea Srague & Riley	achiotillo
Vitex guameri Greenm.	fiddlewood, yaxnik
Vochysia hondurensis Sprague	yemeri
Xylopia frutescens Aubl.	polewood
Zanthoxylum kellermannii Wilson	prickly yellow

APPENDIX 6: MANGROVE COMMUNITY TYPES IN NORTHERN BELIZE

Fieldwork revealed a range of mangrove communities. In line with the classification provided by Lugo and Snedaker (1974) and Cintron and Schaeffer-Novelli (1982), the four principal types identified were:

(i) Fringe mangrove forests
(ii) Saltmarsh with sparse mangroves (widely referred to as mangrove savanna or scrub mangrove)
(iii) Basin mangrove forests
(iv) Riverine mangrove forests

Fringe mangrove forest

Fringing mangroves develop in conditions of permanent inundation, along Belize's protected shores, adjacent to the sea or lagoons, inland waterbodies, and circumscribing large islands (Thom, 1984). In instances where islands are permanently flooded, overwash forests occur, comprising a special form of fringe mangrove.

In all cases, *R. mangle* is the dominant species. It tolerates sustained inundation and has a seed dispersal mechanism adapted to establishment in deeper waters than other mangrove species.

With the limited tidal range of the Caribbean, fringing mangroves occur in relatively narrow belts, although the exact extent depends on topography. Fringe forests observed during field reconnaissance varied between 2 m wide around lagoons, to approximately 60 m wide on prograding shores with shallow gradients. Canopy height generally lies within the approximate range of 2-14 m.

In conditions where tidal scour removes leaf litter, optimal nutrient cycling is prevented. Where this co-incides with areas of poor soils isolated from allocthonous nutrient supply, the growth of fringe mangroves is restricted. Under such conditions, extensive scrubby stands of fringe forests result, with mangrove height limited to approximately 2 m.

Vegetation landward of the fringe forests is determined primarily by topography. Where depressions lead to saline or brackish flooding, basic or marsh communities occur. In areas of higher elevation, salt marsh with sparse mangroves develops if saline intrusion is intermittent. Where saline intrusions do not occur, a gradation into various forms of closed forest results, the classic transition to which is highlighted by Davis (1940) (Figure A6.1).

Saltmarsh with sparse mangrove

Extensive areas of the saltmarsh with sparse mangrove community are found in Belize, northwards of Little Rocky Point, as far as the Rio Hondo, as well as Ambergris Cay (West, 1977). It co-incides with the Corozal Saline Swamps land system consisting of shallow recent calcareous marl with mud, over Pleistocene limestone. It lies within the driest region of the mainland, and lacks ingress of fresh water from major rivers. Consequently, these coastal flats are highly saline (Davis, 1943; Hartshorn *et al.*, 1984). High evapotranspiration and wind desiccation compound the physiological dryness of this environment. The mangrove community is therefore sparse with low biomass (Figure A6.2).

All four mangrove species are present in these mangrove savanna communities. The trees reach as high as 3 m, but generally vary between approximately 0.5-1.5 m. Mangroves occur as individuals or clusters with species zonation produced by *R. mangle* in areas of permanenet inundation, and *C. erecta* on hummocks or higher ground. Ground cover is variable. *Distichlis spicata* and *Spartina spartineae* are present in saltmarsh with sparse mangroves on the north-western side of Ambergris Cay (West, 1977). In addition, ground flora cited in Davis's (1943) descriptions of comparable saltmarsh mangrove communities in

Figure A6.1

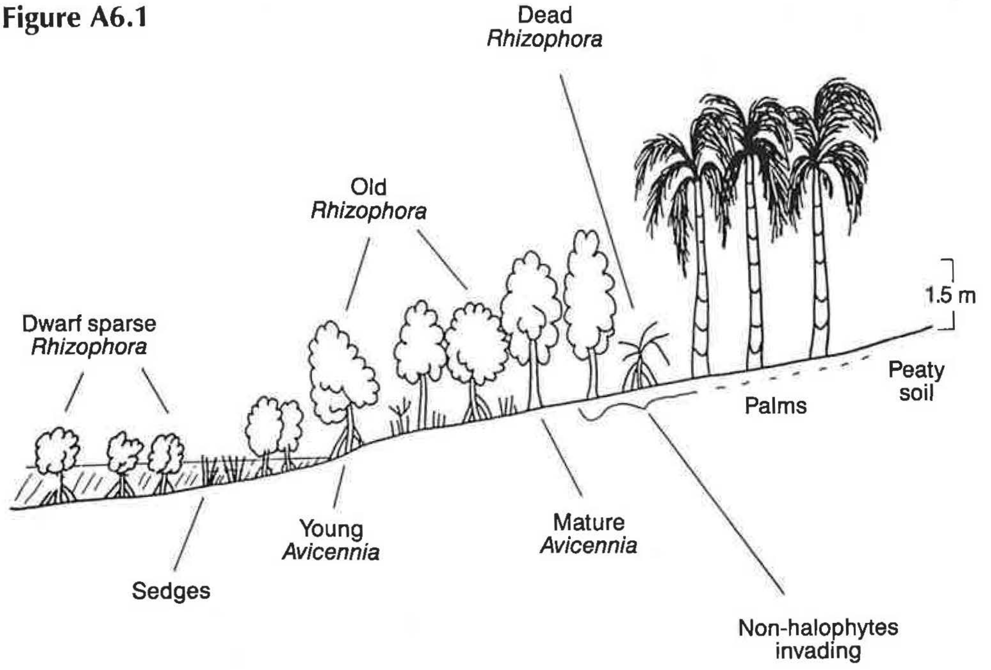
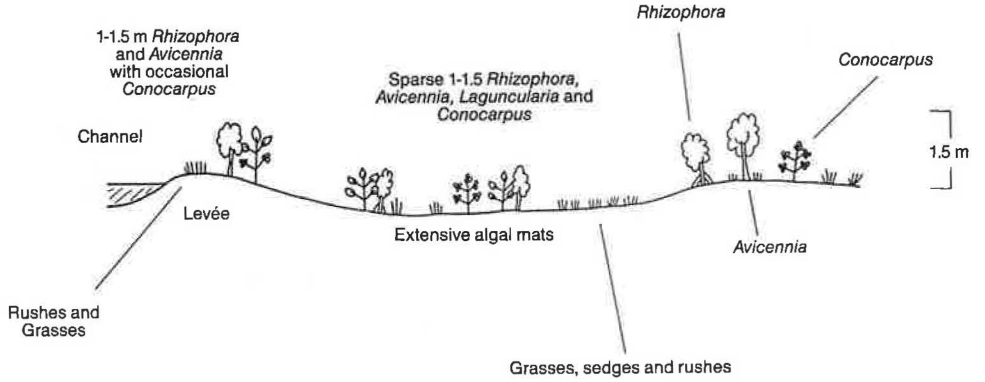


Figure A6.2



Florida suggest that species present may include halophytic bacteria, the saltwort *Batis maritima* L, glasswort *Salicornia perennis* Mill, cord-grass *Spartina cynosuroides* L, salt-grass *Distichlis spicata,* the sedge *Fimbristylis castanea* (Michx) Vahl. Roth., bunch switchgrass *S. bakeria* Merr., and blackrush *Juncus roemerianus* Scheele.

The zonation of these plants depends mainly upon the degree of inundation by tides (David, 1943). Progressing from lower to higher areas within the saltmarsh, *Batis* is dominant, then *Batis* and *Salicornia,* then *Distichlis* with patches of *Spartina* and occasionally *Fimbristylis,* then *Juncus.*

A similar zonation can be expected in Belize's saltmarshes with mangroves. Limits on the time in the field during the mangrove mapping project prohibited detailed species survey in these areas, but the microtopographic zonation of *Batis, Distichlis, Spartina,* and *Juncus* was evident.

Where salinity concentrations are prohibitive and the ground is too dry for halophytic algae, bare ground results.

The majority of these saltmarsh with sparse mangrove areas are only intermittently inundated, during extreme tides and/or storm surges. No topographic measurements were made although approximate estimates suggest the community lies between sea level and 1.5 m.

Basin mangrove forests

Behind river levees and strand plains and in various drainage depressions, basin communities develop (Figures A6.3 and A6.4). Surface hydrology is characterized by sluggish laminar water flows over wide areas of very small topographic gradients. The water turnover rate is slow, with basins receiving and storing water seasonally (Cintron and Schaeffer-Novelli, 1982). Species composition and forest structure are highly variable, depending on the frequency and depth of inundation, the input/output of nutrients, and levels of salinity.

Where basins receive frequent tidal flooding or where floodwaters are predominantly deeper than 15 cm, basin communities are dominated by *R. mangle* (Lugo and Snedaker, 1974). Tidal creeks and drainage channels within other basin forests are also likely to be lined with *R. mangle*.

Where water depth is less, and where tidal flushing, tidal amplitude and the kinetic energy of floodwaters decrease, other mangrove species invade. Salinity reaches high levels but is also liable to wide fluctuations in response to rainfall.

Figure A6.3

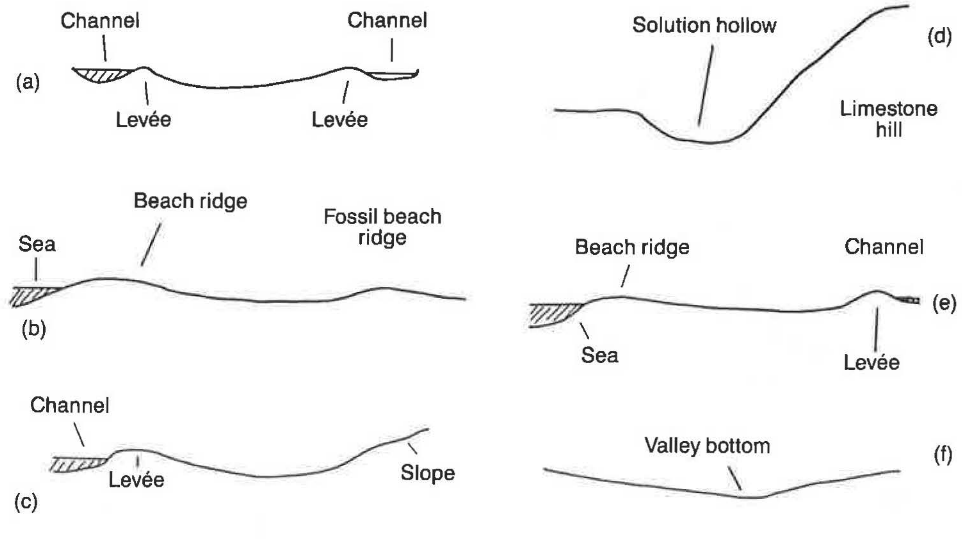
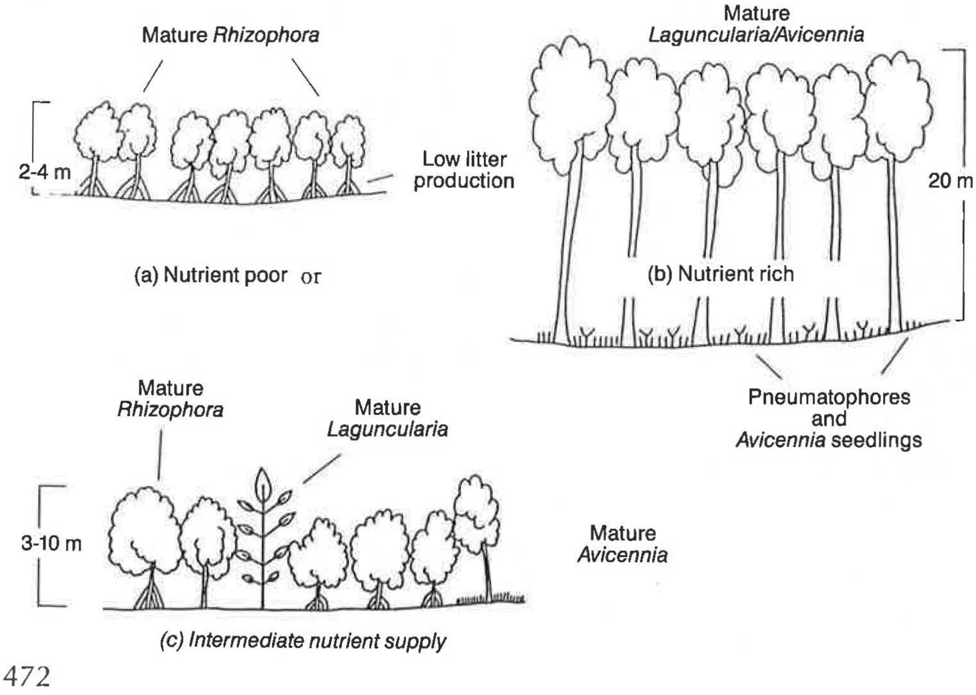


Figure A6.4



Basin waters under these conditions may be stagnant and depleted in oxygen. Where salinity condtions exceed 50 ‰, basin forests are dominated by *A. germinans*. Mixed forests are likely to be indicative of intermediate salinity (30-40 ‰) and *L. racemosa* dominates where salinities are lower (Cintron and Schaeffer-Novelli, 1982). Forest height varies according to the nutrient supply. Behind river levees or adjacent to river mouths, for instance, intermittent tidal and freshwater flooding may deliver large quantities of nutrient-rich sediment. Tall mangrove forests result. This appears to be the origin of the basin mangrove forests to the west and north-west of Belize City which attain a height of approximately 23 m.

Basin mangroves also occur in a dwarf form, and where trees range from approximately 1.5-3.5 m in height. In comparable communities in Florida, Cintron and Schaeffer-Novelli (1982) suggest the stunted form results from oligotrophic soil and water conditions. This explanation is likely to apply in the Belizean case.

The presence of ground flora in basin forests depends on the depth of inundation and canopy density. Where water is relatively shallow under *A. germinans* stands, halophytic algae and tree seedlings are common. Only a relatively small proportion of the latter, however, survive beyond their first year (Rabinowitz, 1978). Where a thin canopy and shallow water combine under dwarf *R. mangle* forests, extensive areas of sedges may be present.

Scattered and sometimes extensive areas of basin mangroves, dominated by *R. mangle*, occur in several inland locations seemingly cut off from the influence of saline water. The mangrove area around Pepperswamp Lagoon in south-west Corozal District is one example. Subsidence of underlying peats resulting in permanent inundation is one possible explanation. Alternatively, the mangroves may be relics from earlier coastal configurations, or have been introduced during periods or episodes of more widespread inundation, as suggested by Davis (1940) and Stoddart *et al.*, (1972). The similar occurrence of fringing mangroves around inland waterbodies can also be explained by these factors.

Riverine mangrove forests

In contrast to the nutrient-poor environments of some basin mangrove communities, riverine mangrove forests receive a substantial input of nutrients from the watersheds of the rivers along which they grow. These forests are generally the most productive of all mangrove ecosystems, and trees are significantly taller, ranging from approximately 10 m to a maximum of approximately 30 m along sections of the Temash River in Toledo District outside the project area (Weyer, 1988, personal communication).

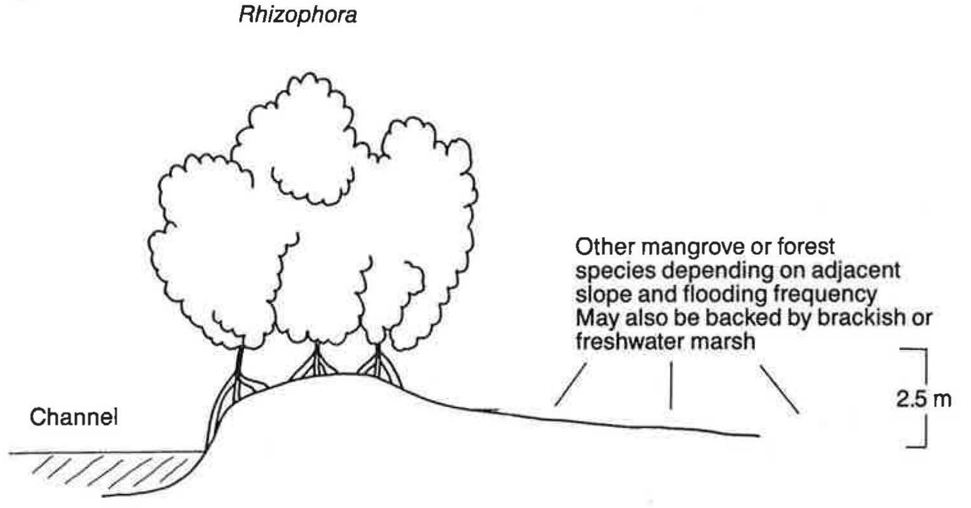
R. mangle is the dominant species along the river banks (Figure A6.5), while herb and algal growth tend to be limited because of the dense shade cast by the thick canopy. One notable exception to the domination of *R. mangle* can be found adjacent to artificial canals, where *L. racemosa* has a tendency to colonize banks of dredge spoil to form pure stands (see, for instance, Gledhill, 1983). Mangroves at the southern exit of Jones Lagoon on the Burdon Canal are one such example in Belize. The plant community landward of riverine mangroves varies widely, according to topography.

Minor mangrove communities

Three additional communities in Belize include mangroves.

In the first, isolated trees or clumps of dwarf *R. mangle*, with a canopy height up to approximately 3.5 m, occur as 'islands' amongst extensive open brackish water swamps colonized by tall sedge vegetation. Common among these tussock-forming Cyperaceae are *Fuirena* and *Mariscus* species (Standley and Record, 1936). In the second, a similar landscape is formed, but in freshwater conditions, with large expanses of sedge and reed vegetation interspersed with

Figure A6.5



clusters of dwarf *R. mangle*. This frequently occurs at some distance inland, an example being the swamps south of the Western Highway at Almond Hill Lagoon outside the project area.

The third minor mangrove type is the disturbed community. This can result from both human and natural disturbances, where impacts induce persistent changes in environmental conditions. The re-establishment of original mangrove communities is prevented or delayed over substantial periods. An increasingly common plagio-climax of this kind, which results from artificial mangrove clearance, is mono-specific stands of the fern *Acrostichum aureum*. This is a light-demanding species which, once established, can preclude succession of other plants (West, 1977). Depending on the conditions in which it grows, estimates during fieldwork suggest the stands vary from approximately 1-2 m in height. It was, however, noticeable that *Achrostichum* invasion was retarded where mangrove brashings were still present after cutting. This may be due to lower light penetration under these circumstances, or simply the lack of time since clearance for *Acrostichum* colonization.

One further consideration relating to disturbed communities resulting from human impacts, is the extent to which the activities of previous Maya populations influenced mangrove community composition and distribution. This remains uncertain, but given the evidence of widespread and dense human settlement, the present distribution of mangroves should be interpreted with at least some reference to possible historical impacts.

The extent to which natural perturbations lead to disturbance of mangrove communities is also particularly important in Belize because of the catastrophic impact of tropical storms and hurricanes. The main cyclone season for Belize is between the months of September and November with winds ranging from 65 km/h in a tropical depression to more than 119 km/h in a hurricane (Cintron and Schaeffer-Novelli, 1982). Wind speeds greater than 93 km/h can cause defoliation either physically or through 'burning' from salt spray. This may account in part for the limited extent of tall mangroves in the Shipstern region, which was subject to a damaging hurricane in 1966.

Mangrove protection

The network of mangrove roots prevents storm and hurricane erosion of the poorly consolidated coastal soils. The physical structure of the mangrove forests also absorb the wave energy of storm surges. Clearing mangrove destroys both these coastal protection functions of mangrove. Expensive sea defences are required, while the threat to loss of life and property from hurricanes is increased.

Large-scale mangrove clearance in El Salvador and elsewhere has led to reduction in fisheries catches, because mangroves provide shelter for many commercially important fish, shrimp and crab species. They also act as nursery grounds where many of these animals go through their initial growth phases.

The mangrove islands of the cays, and the Burdon Canal down to Gales Point have substantial value as an eco-tourism resource. Interesting wildlife opportunities for controlled sport and local fishing, sailing, diving and other activities make these areas ideal for multiple use by visitors and local people. Clearance of the mangroves on the cays and adjacent to the Burdon Canal in particular, threaten to destroy this opportunity even before it has been fully developed.

APPENDIX 7: 1989 PROJECTED VILLAGE POPULATIONS

Community	Total 1989 population	Projected 1989 population at natural growth rate	Presence of refugees/other immigrant categories
Corozal District			
Buena Vista	330	422	*
Calcutta	709	908	
Caledonia	942	1206	*
Chan Chen	351	449	*
Chunox	439	562	
Concepcion	608	778	*
Cristo Rey	377	483	
Libertad	1518	1943	
Little Belize	329	421	
Louisville	436	558	*
Paraiso	510	653	
Patchakan	700	896	*
Progresso	781	1000	*
Ranchito	604	773	
San Andres	459	588	
San Antonio	264	338	
San Joaquin	929	1189	
San Narciso	1436	1838	
San Pedro	271	347	
San Roman	448	573	*
San Victor	349	447	
Santa Clara	449	575	*
Sarteneja	1050	1286	*
Xaibe	760	973	*
Orange Walk District			
Augustine Pine Ridge	885	1133	*
Blue Creek (Mennonite)	661	846	
Chan Pine Ridge	291	373	
Douglas	453	580	
Guinea Grass	1291	1652	
San Antonio (Rio Hondo)	345	442	
San Estevan	978	1252	
San Felipe	585	749	*
San Jose	1164	1490	*
San Jose Nuevo (San Jose Palmar)	477	611	*
San Lazaro	567	726	*
San Lorenzo Road	404	517	*
San Pablo	638	827	*
San Roman (Rio Hondo)	352	451	
Shipyard	2446	3131	
Trial Farm	483	618	*
Trinidad	423	541	*
Yo Creek	810	1037	*
Belize District			
Ambergris Cay	1136	1454	*
Burrell Boom Area	684	876	*
Crooked Tree	508	650	
Ladyville (Haulover Bridge to Boom Cut Off)	1806	2312	
Maskall	675	864	*
Sand Hill Area	412	527	
Cayo District			
Lower Barton Creek	230	294	
San Antonio	736	942	*

Source: Foster (1989)

APPENDIX 8: ILLUSTRATION OF WAGES, SALARIES AND OTHER EMPLOYMENT EXPENSES BASED UPON ENQUIRIES CONDUCTED IN MAY, 1990

A WAGES AND SALARIES

1 **Public Sector** (Budget of Belize 1990/1991)

	Salary BZ$/year	Median Equivalent BZ$/day
(a) *Salaries* (39.5 h/week)		
Livestock Attendant	4020 – 8808	24.67
Forest Guard or Trainee Forest Officer	5220 – 11376	31.92
Foreman (Agriculture)	5220 – 11373	31.92
Farm Superintendent or Senior Extension Officer	10020 – 18684	55.20
Agricultural or Forest Officer	16212 – 29436	87.78

(b) *Daily Wage*	Wages BZ$/day
Agricultural Worker (BZ$ 1.94/h)	17.46 (45 h/week)

2 **Private Sector**

* Paid Vacation leave ranges from 2 – 5 weeks depending upon length of service.

* Annual bonuses, where applicable, usually range from 5 – 10%.

(a) *Daily Wage*	BZ$/day (9 h)
Bulldozer Operator	50 – 75 depending upon location
Workshop Mechanical Supervisor	50
Workshop Mechanic	35 – 40
Professional Herdsman (>200 Head)	24 – 35
Agricultural Worker: pasture maintenance; weeding; grass transplanting; fence repair etc.	12.50 – 20
(b) *Hourly Wage*	BZ$/h (usually 9 h/day)
Industrial Worker (permanent)	3.10 – 3.40 (8 h/day)
Industrial Worker (casual)	2.00 – 2.80 (9 h/day)
Tractor Driver	3.50 – 3.70
Large-scale Agricultural Estate Workers (permanent)	1.95 – 2.80 (sometimes with lodging)
Other Agricultural Workers (permanent)	1.50 – 2.50 (sometimes with lodging)
Licenced Migrant Workers:	
Farm Foreman	3.00 – 3.50 (sometimes with lodging)
Agricultural Worker	1.80 – 2.20 (sometimes with lodging)
Agricultural trainee	1.00 (sometimes with lodging)
(c) *Sugar Cane*	BZ$/t
Cutting	8 – 10 by contract crews;
Loading	2 – 3 3-4t/Manday approx.

3 **Minimum Wages**

	BZ$/h
Retail Assistant	
Dry Goods	1.25
Clubs, Restaurants	1.50
Domestic Services	
Private	1.10
Institutions	1.25

B OTHER EMPLOYMENT EXPENSES

1 **Social Security Contributions (all employees)**

Earnings BZ$/week	Employee Contributions (BZ$)	Employer Contributions (BZ$)
70 – 110	0.90	5.40
>110	1.30	7.80

Source: Social Security Board

2 **Work Permit Fees/Person**

	BZ$
Agriculture – seasonal	25
– general, 12 months	100
– general, 6 months	50
– general, 3 months	25
Alien, self-employed farmer – 1 year	10
Professional	500 – 600

Source: Labour Department

APPENDIX 9: LAND EVALUATION OF SAN FELIPE NATIONAL LAND

The Distribution of Land Holdings section in the main text indicated 13,000 ac (5000 ha) of land south of San Felipe, were available for settlement. In terms of land systems, the land comprises 9000 ac (4000 ha) of Shipyard Plain, 3000 ac (1000 ha) of Lazaro Plain, 900 ac (400 ha) of San Felipe Plain and 80 ac (30 ha) of August Pine Plain. Calculating agricultural values from the table accompanying Map 1c indicates 6500 ac (2500 ha) of agricultural land with a good chance of financial success, 4500 ac (1500 ha) with a moderate chance of financial success and 2000 ac (100 ha) with only a marginal chance of financial success. Nutrients are a limiting factor throughout the block, but two thirds of the block have root room and workability limitations, and over half the block has poor drainage, which is most of the land not yet cultivated.

A more detailed analysis of the table accompanying Map 1c indicates most of the land is highly suitable for timber and sugar cane, highly to moderately suitable for milpa, pasture and sorghum, moderately suitable for beans, groundnuts and maize, moderately to marginally suitable for papaya and marginally suitable for cotton, coconuts and root crops. About a quarter of the land is highly to moderately suitable for pineapple and about an eighth is moderately suitable for cashew. However, of the land not yet cultivated, most of it is poorly drained, moderately to marginally suitable for pasture and possibly for rice. Some of it may be suitable for maize, sorghum, sugar cane and matahambre milpa.

APPENDIX 10: ILLUSTRATIONS OF ROAD CONSTRUCTION AND MAINTENANCE COSTS

Specification: Marl, 22 ft (6.7 m) gross, 18 ft (5.5 m) net, with culverts.

Construction: BZ$ 25,000/mile (BZ$ 16,000/km)
Extra charge for long haulage of full and/or swampy conditions
BZ$ 3000 – BZ$ 9000/mile (BZ$ 2000-BZ$ 6000/km)

Maintenance: BZ$ 2000/mile/year (BZ$ 1000/km/year)

Road Transportation Costs

(a) *Sugar Cane*	BZ$/t
Buena Vista – Tower Hill (16 miles (26 km))	12
Santa Elena – Tower Hill (40 miles (64 km))	18
Corozal District Average	15
San Felipe – Tower Hill (22 miles (35 km))	15
Orange Walk District Average	11
(b) *Fertilizers*	BZ$/50 kg bag
Belize (Western Highway) – Corozal (81 miles (130 km))	1.25
Santa Elena – Corozal (8 miles (13 km))	0.65
Orange Walk – Little Belize (20 miles (32 km))	2.00
Orange Walk – Shipyard (15 miles (24 km))	1.70 – 2.50
(c) *Grains*	BZ$/100 lb bag
Shipyard – Spanish Lookout	2.00
(d) *Cattle*	BZ$/lb/net weight
Blue Creek – Ladyville (90 miles (145 km))	0.30 (full load)
Shipyard – Ladyville (@ BZ$20/head)	0.30 (full load)
(e) *Containerized Honey*	BZ$/20 ft Container
(20 ft (6 m) Container: 68 Drums)	
Orange Walk – Belize Port	375
Belize City area only	80
(40 ft (12 m) Container general cargo/Belize City area only:	120)

Vehicle Licensing – unladen weight	BZ$/year
Private < 3000 lb (1360 kg)	100
Private > 3000 lb (1360 kg)	150
Goods < 3000 lb (1360 kg)	125
Goods 3000 – 4000 lb (1360 – 1815 kg)	150
Goods 4000 – 10000 lb (1815 – 4535 kg)	250

Public Transport

Maximum single fares, in force since 1988, are:

(a) *Bus*	BZ$
Belize City – Orange Walk	3.50
Belize City – Corozal	6.00
Belize City – Santa Elena	7.00
Orange Walk – Corozal	2.50
Corozal – Santa Elena	1.00
San Narciso – Corozal	1.00
Sarteneja – Santa Elena	7.00
Sarteneja – Belize City	8.00
(b) *Taxi* – within town/city limits	4.00
Belize City – International Airport	20.00

Source: Licensing and Transport Board

APPENDIX 11: SHIPPING CHARGES

Ocean Freight

Product/Route	Journey Time (days)	Container Description	Min Load (lb)	Rate (BZ$)	Cost/ Container* (BZ$)
Fresh Fruit/Veg. Belize – Florida	4	20 ft Reefer 40 ft Reefer	20,000 35,000	90/lb	1800 3150
Fresh Papaya Belize – Florida	4	20 ft Reefer 40 ft Reefer (High Cube)	10,000 25,000	130/lb	1300 3250
Frozen Citrus Concentrate or Mango Puree Belize – Florida (55 gal drums)	4	20 ft Reefer 40 ft Reefer	– –	– –	3300 5530
Frozen Produce incl. fish/shrimp Belize – Florida	4	20 ft Reefer 40 ft Reefer	20,000 35,000	$280/2000 lb	2800 4900
Frozen Lobster Belize – Florida	4	20 ft Reefer	12,000	$300/2000 lb	1800
Sawn Lumber Belize – Florida		20 ft Dry Box	–	–	500
Chilled or Frozen Belize – Felixstowe, UK	21	20 ft Reefer 40 ft Reefer	(Est. 7-8 t) (Est. 14-16 t)	– –	6454† 9968†
Dry Produce Belize – Felixstowe, UK	21	20 ft Dry Box 40 ft Dry Box	– –	– –	5600† 8450†
Fresh Produce Big Creek – Portsmouth, UK	12	20 ft Reefer 40 ft Reefer	Negotiable	Negotiable	3000 6000

* Excludes handling and loading charges; ignores promotional rates.
† Includes Belize handling and landing charges.

Belize Port Authority Charges, May 1990

Containerized (dry or reefer) cargoes: illustrations

		BZ$		
		Handling	Cargo Dues	Total
20 ft Container (say 20 t)	Import	360	112,80	472,80
	Export	360	56.40	416.40

	BZ$	
BPA Tariff (since 1980)	Import	Export
Handling/40 ft³ or 2,000 lb	18.00	7.50
Administration charge* of no: BPA Handling/40 ft³ or 2,000 lb	6.00	6.00
Cargo loading/40 ft³ or 2,000 lb	5.64	2.82
Heavy lifting within compound (i.e. cargo parked in compound) /2000 lb weight basis*	6.00	6.00
Warehouse dry storage, in bound		
Up to 7 days: /40 ft³ or 2,000 lb	Free	
8 – 14 days /40 ft³ or 2,000 lb	2.00	
15 – 21 days /40 ft³ or 2,000 lb	3.00 (plus prior charges)	
22 – 28 days /40 ft³ or 2,000 lb	5.00 (plus prior charges)	
>29 days /40 ft³ or 2,000 lb	7.00 (plus prior charges)	
Loading ex warehouse to vehicle/40 ft³ or 2000 lb	300	

* Introduced 1987
† Manifested or measured, otherwise 20 t/20 ft container; 40 t/40 ft container

Source: Belize Port Authority

Other Charges (68 drums)
Container (20 ft) delivery/to port from Belize City BZ$375.

Source: Belize Honey Producers Federation

Note: Big Creek port is a privately owned port, subject to BPA restrictions on its use

APPENDIX 12: INTERNATIONAL AIR CARRIERS AND AIR ROUTES: ILLUSTRATIONS OF AIR FREIGHT RATES

1 **Passenger Transport** (limited cargo-carrying capacity)

(a) *TACA (Transportes Aereas Centroamericanas, El Salvador)*

Belize – Miami – Belize	(daily)
Belize – Houston – Belize	(every 2 days)
Belize – New Orleans – Belize	(every 2 days)
Belize – San Salvador – Belize	(daily)

Connections:
San Salvador – San Jose
San Salvador – Panama City
San Salvador – Guatemala City
San Salvador – Los Angeles
San Salvador – Mexico City

(b) *TAN-SAMSA* (Honduras)

Belize – San Pedro Sula (SPS) – Tegucigalpa – SPS – Belize	(daily)
Belize – Miami – Belize	(daily)
Belize – New Orleans – Belize	(every 2 days)
Belize – Houston – Belize	(every 2 days)

Connections:

Tegucigalpa – Managua – San Jose	(daily)
Tegucigalpa – Guatemala City	(daily)

(c) *CONTINENTAL AIRLINES (USA)*

San Pedro Sula – Belize – Houston – Houston – San Pedro Sula – Belize	(daily)

(d) *TROPIC AIR (Belize)*

Belize – Cancun	(daily)

2 **Cargo Transport**

BELIZE AIR INTERNATIONAL (Belize)	
Belize – San Pedro Sula – Miami – Belize	(Saturday only)

(Licences Applied For:
Belize TransAir – Passenger – Belize – Miami
American Airlines – Passenger – Belize – Miami)

3 **Illustration of Air Freight Rates**

Rates that have been applied since 1988 are:

		Costs	
Product	Route	BZ$/lb	BZ$/kg
Cut Flowers × 14 lb (6.4 kg) max. load 420 lb (191 kg)/flight	Belize/Houston	6.34 (1988)	2.88 (1988)
Papaya × 10 lb (4.5 kg) × 12 (i.e. 120 lb (55 kg) cases	Belize/Houston	8.58 (1989)	3.90 (1989)
Papaya × 10 lb (4.5 kg) × 12	Houston/Tokyo	1.00 (1989) (special rate)	0.45 (1989)
Papaya (min 1100 lb (500 kg)	Houston/London	1.80 (1990) (quote only)	0.82 (1990)

APPENDIX 13: COSTS AND RETURNS OF MECHANIZED GRAINS PRODUCTION (FULLY COSTED)

Crop

Normal Season	*Maize** May-October	*Sorghum** Dec-April	*Red kidney beans* Dec-April
Assumed yield lb/ac	2000	2000	500
Price BZ$/lb (Belize) (or Spanish Lookout)	0.18	0.155	1.00
Gross Revenue/ac	360	310	500
Operations BZ$/ac			
Light Plough (1 ac/h)	30	30	30
Harrow (1.5 ac/h)	20	20	20
Bed (2 ac/h)	15	15	15
Plant and Fertilize (1.5 ac/h)	20	20	20
Weed/Pest Control (2 ac/h)	30 (2x)	30 (2x)	90 (6x)
Combine Harvest (BZ$ 1.75/100 lb)	35	35	–
(BZ$ 2.00/100 lb)			10
Drying/Clearing (Notional)	15	15	9 (Sun Platform)
Transport (BZ$ 2.00/100 lb)	40	40	10
Materials (BZ$/ac)			
Seed	18.85 (131 lbx1.45) (Pioneer)	160 (10 lb own seed)	30 (20 lbx1.50) (Imported USA)
Fertilizer (100 lb)	35	35	35 (75-150 lb)
17:17:17 (sands) 18:46:0 (clays)			
Herbicides/Insecticides	10	10	40
Materials transport	4	4	4
	272.85	255.60	313.00
Gross margin/BZ$	87.15	54.40	187.00
Gross margin %	31.9	21.3	59.7

*May be undersown with pasture grasses

APPENDIX 14 : GOODS WHICH REQUIRE AN IMPORT LICENCE PRIOR TO IMPORTATION

1. Beans and peas (except canned)
2. Bleaching agents
3. Eggs in shell as classified under Customs Co-operation Council Nomenclature Tariff Heading 04.05.
4. Flour except cornflour used as a cereal
5. Fresh fruits and vegetables excluding onions and garlic
6. Furniture made of wood or any other material
7. Lumber and articles made of wood excluding plywood and decorated panelling
8. Meats (all types) and meat preparations excluding canned soups
9. Sugar and molasses excluding Icing Sugar
10. Wearing apparel: – T-Shirts (all types) for commercial purposes
11. Beer and beverages as classified under Customs Co-operation Council Nomenclature Tariff Heading 22.03 and 22.03 respectively with the exception of dietetic beverages
12. Maize except popcorn
13. Rice
14. Cement tiles and blocks
15. Milk of all kinds except for powdered milk in cans
16. Gases (butane, oxygen and acetylene)
17. Poultry (live, fresh, chilled or frozen) except for baby chicks
18. Citrus and beverages containing citrus products
19. Jams, jellies and pepper sauce
20. Macaroni, spaghetti, vermicelli, macaroni and cheese dinner and other similar dry pasta products
21. Matches
22. Animal Feed as classified under Customs Co-operation Council Nomenclature Tariff Heading 23.07
23. Fertilizer
24. Toilet paper and paper bags
25. Peanuts and peanut butter
26. Ships and boats of Customs Co-operation Council Nomenclature Tariff Heading 89.01 to be entered in accordance with Chapter 38, Section 15 (1) and Chapter 39, Section 16 (1) of the Laws of Belize, 1980
27. Spear-guns

APPENDIX 15 : BELIZE COLLEGE OF AGRICULTURE GRADUATE PLACEMENT ANALYSIS 1980-8

1	Ministry of Agriculture	(a) Extension Officers	26 (14.27%)
		(b) Quarantine Inspectors	9 (4.91%)
		(c) Dairy Officers	2 (1.09%)
		(d) Technician	9 (4.91%)
			46 (25.18%)
2	NGO (CARDI, DFC, PCB, CARE, BEST, BARD, Help for Progress, Co-op, Credit Union)		28 (15.3%)
3	Agriculture Teachers		13 (7.1%)
4	Farming: self-employed		34 (18.58%)
5	Further studies in Agriculture		9 (4.91%)
6	Private Industry (BSI, BFP, Others)		13 (7.1%)
7	Non-Agricultural related appointments (Police, BDF)		9 (4.91%)
8	Emmigration (US, Canada)		17 (9.29%)
9	Unemployed		8 (4.37%)
10	Deceased		2 (1.09%)
11	Unknown		4 (2.18%)
		Total	183 (100%)

Compiled by Barrett, R and Thompson, R., Belize College of Agriculture

APPENDIX 16 : MECHANICAL SERVICES (AND EQUIVALENT LABOUR-INTENSIVE SERVICES)

	BZ$/ha	BZ$/ac (includes operators and fuel)	
1 **Land Clearing**			
Mechanized, complete (medium to high bush), including ploughing	1330-1480	540-600	plus royalty on extracted lumber
Mechanized (medium to high bush), cleared to windrows at 100 yd (91 m) interiors	990-1240	400-500	plus royalty on extracted lumber
Mechanized (medium to high bush) knocked-down and burned, not cleared	440- 540	180-220	plus royalty on extracted lumber
Mechanized felling, by chain	270- 350	110-140	(High bush)
(2 Crawlers; 2 passes)	220- 300	90-120	(Medium bush)
(2 Crawlers; 2 passes)	210- 270	85-110	(Cohune*)
Burning	50- 70	20- 30	
Manual (axe and chainsaw) felling and burning	350- 400	140-160	(Medium Bush)
	270- 300	110-120	(Low Bush)
	120- 150	50- 60	(Wamil (regrowth))
Forest thinning and 100% trash removal (cacao)	1480	600	

*Alternatively wound and await natural decomposition.

Wamil (regrowth) : mechanized stumping	140- 160	55- 65	
2 **Land Preparation**			
Rome plough	190- 220	75- 90	
3-disc light plough	54- 62	22- 25	
Heavy harrow	140- 160	55- 65	
Light harrow	15- 20	6- 8	
Bedding (Cane)	62- 86	25- 35	
Seed and fertilizer drilling	17- 22	7- 9	

	BZ$/100 lb bag
3 **Combine Harvesting**	1.75-2.00

4 **Machinery hire**	BZ$/h (including operator and fuel)
Bulldozer D5	60
Bulldozer D6	70-100 (Capacity: 500 ac (200 ha) cleared/year approx.)
Bulldozer D7	120
Bulldozer D8	125-160 (Capacity:1000 ac (400 ha) cleared/year approx)
Dragline (0.75 yd^3, 0.57 m^3)	90
Tracked excavator (2 yd^3, 1.5 m^3)	150 (or BZ$ 1.50-BZ$ 2.00/yd^3. (BZ$ 1.96-BZ$ 2.62/m^3); BZ$ 4/yd^3 (BZ$ 5/m^3) if operating on mats)
Small tracked excavator (0.20 yd^3, 0.15 m^3)	50
Tracked front-end loader (2 yd^3, 1.5 m^3)	90
Bach hoe (0.3 yd^3, 0.2 m^3)	50-90
Grader	75-120
Low-bed lorry	70-80
Dump truck (20 t; 10 wheels)	35*
Dump truck (8 t, 6 wheels)	25
4-wheel drive tractor	40-50
2-wheel drive tractor	25-30
2000 gal (9100 l) water tanker	40
Tillage implements	10-15 (if charged)

* or 35-40 cent/yd^3/mile (29-33 cent/m^3/km): 28-33 cent/yd^3/mile (23-27 cent/m^3/km) (gravel) or BZ$ 5.60/mile (BZ$ 3.48/km) (gravel): load = 20 t or 14 yd^3).

5 **Workshop services**	BZ$/h
Labour and overheads	Up to 20

APPENDIX 17 : ILLUSTRATION OF COSTS AND RETURNS FOR A NON-MECHANIZED, SELF-FINANCING CANE FARMER (LABOUR INPUT : ALL-PAID @ BZ$ 18/MAN DAY)

1 A **Establishment (year 1) – Labour**

Operation	*Man day*	BZ$/ac	BZ$/ha
Land preparation	8		
Planting and seedbed fertilizer	4		
First weeding* @ 3 months	2		
Second weeding @ 6 months	5		
Fertilizer @ 6 months	0.5		
Total	19.5	351	867

B **Establishment (year 1) – Materials**

Item	*Unit*	*Rate BZ$*	*BZ$/ac*	*BZ$/ha*
Seed transport	4 t	10	40	99
Cane seed (BSI improved)	4 t	27.50	110	272
Fertilizer 1.0:46:0	2 bags (100 kg)	30.00	60	148
Fertilizer 2.28:28:0	1 bag (50 kg)	37.00	37	91
	Total		247	610

Total Establishment, say BZ$ 600/ac (BZ$ 1500/ha))

2 A **Ratoon – Annual Maintenance expense (years 2-11) – Labour**

Operation	*Man days*†	*BZ$/ac*	*BZ$/ha*
Cleaning fields after previous harvest	0.5		
Weeding, 2-5 months after harvest	2		
Fertilizer	0.3		
Replant 10%	1.5		
	4.3	77.4	191

B **Ratoon (years 2-11) – Materials**

Item	*Unit*	Rate BZ$	BZ$/ac	BZ$/ha
Contract ridging (mech.)	–	Contract	35†	86
Fertilizer 46:0:0	1 bag (50 kg)	28	28	69
	Total		63	156

Total Annual Maintenance, say BZ$ 150ac (BZ$ 370/ha)

Note: For the purposes of illustration, application of insecticides has been excluded, as this is not a routine operation.

3 **Volume Variable Costs**

Harvesting and Transport	BZ$/t
Cut and Load (contract rate)	12
Transport (contract rate, average all farms)	11
CFA Cess, say	1
Total	24

4 **Annual costs and returns @ 18 tons Cane/Acre (45t/ha)**

	BZ$					
@ Cane price/t:	30	35	40	45	50	55
	BZ$/ac					
Gross revenue	540	630	720	810	900	990
Volume variable cost	432	432	432	432	432	432
Annual fixed cost	150	150	150	150	150	150
Establishment amortization @ 10%	60	60	60	60	60	60
Gross margin/ac (loss)	(102)	(12)	78	168	258	348
/ha (loss)	(252)	(30)	193	415	637	860

* Alternative is Knapsack spray herbicides @ BZ$ 10/ac (BZ$ 25/ha) Labour x BZ$ 20/ac (BS$ 49/ha) materials

† After Quan (1989)

APPENDIX 18: FEASIBILITY OF ESTABLISHING A GEOGRAPHICAL INFORMATION SYSTEM (GIS) IN BELIZE

Summary

Belize is rapidly approaching the point where it needs to adopt a more positive approach to rural land use planning. The increasing pace of development and the need to reconcile the interests of agriculture, tourism, conservation, forestry and urban expansion suggest an inter-sectoral and integrative approach is required. This cannot develop unless the basis for policy, that is, the data relating to land resources and land use, are themselves integrated as can now be achieved by computer-based Geographical Information Systems (GIS).

Adoption of GIS technology should be accompanied by a physical planning structure designed to formulate policy guidelines, instigate legislation and co-ordinate and implement plans.

The role identified for a GIS within Belize is extremely wide. Potential applications have been noted ranging from the needs of policy-makers through to the everyday requirements of the agricultural extension service. Further, there are a number of reasons to suggest that the technical and operational problems experienced in some other developing countries need not apply to Belize.

This summary lists the principal recommendations of a study into the feasibility of establishing a GIS within the government structure of Belize.

Recommendations

Institutional

1. A separate Land Information Centre (LIC) responsible to the Ministry of Industry and Natural Resources should be established in Belmopan.

2. The LIC should be split into two divisions, one to handle the proposed Land Information System (LIS); the other to handle GIS operations. These divisions should use the same computer network and adopt the same standards of data referencing, i.e. Universal Transverse Mercator (UTM), and other data-related issues.

3. Both divisions should be under the supervision of the LIC director.

4. A Conservation Data Centre (CDC) should be established as a sub-division of the GIS division. It would be fully supported by the 'Programme for Belize' and represent the GIS section of a wider Conservation Data Centre also to be based in Belmopan.

5. A GIS project manager should be appointed to manage the GIS division of the LIC. This individual, responsible to the LIC director, would form the interface with all bodies requesting information from the GIS. The GIS project manager would also be charged with undertaking any technical liaison required in the course of GIS operations.

6. A high-level inter-ministerial land use committee should be established. It would determine policy guidelines for rural land use planning and instigate the necessary legislation for implementing subsequent plans.

7. A National Physical Planning Unit, responsible for drawing up plans within set policy guidelines should be established. It could be staffed by planning officers from the various ministries concerned with land use. The LIC would supply the information needs of this unit.

8. The GIS division should be encouraged to develop links with non-governmental organizations and the private sector. Both are seen as likely sources of data and, in the case of the latter, a potential source of funds to offset recurrent and capital costs.

Technical

9. The ARC/INFO GIS software should be used as the basis for all the operations of the Land Information Centre. This software has been used extensively for both LIS and GIS operations throughout the developing world. It is well-supported and its functionality is likely to increase dramatically in the next few years.

10. There should be further research to determine the most suitable hardware configuration for the Land Information Centre. The most likely configuration is a network of powerful graphics workstations. Particular care should be taken to ensure that software password and file protection capabilities exist.

11. Maintenance contracts should be taken out on all hardware and software acquired for the LIC. They will represent a considerable recurrent cost and should be included as part of any funding proposal (for a minimum of 5 years).

Staffing

12. Staffing levels should ensure available equipment is used to its full potential.

13. All staff should be trained in all aspects of GIS operations, from base map preparation through digitising, editing, coding, data manipulation and output. Staff should be rotated around these tasks, ideally, following a particular dataset from start to finish.

14. Staff for the GIS division should be chosen on the basis of training in one of a range of land-related specializations e.g. agriculture, geology, soil science. Computer experience is essential.

15. There should be provision for secondment of individuals to the GIS division from requesting bodies in connection with specific projects.

16. There should be a system manager with extensive knowledge of computing, who will be charged with day-to-day management of the computer system, back-up operations, etc.

Training

17. Training should be carried out *in situ* based over a number of months. It should involve a wider theoretical aspect as well as instruction in GIS software and related practical work.

18. The GIS project manager should be sent on a degree-level GIS programme.

19. During the period when the full-time project manager is receiving training overseas, the individual brought in to provide the training course could adopt the role of project manager. This should overcome many of the preliminary technical and organizational problems. This role would end shortly after the return of the full-time manager.

20. 'Awareness' workships should be held during the early stages of implementation, primarily to educate those involved in policy-making and planning roles as to what to expect from the GIS.

Operational considerations

21. All data input should be logged in order to establish rules regarding the limitations of particular datasets, particularly where a change of scale is likely between input and output.

22. Rigid operational procedures should be established to ensure data quality and consistency.

23. Data security can be achieved by limiting the amount of attribute information stored for a particular feature, by maintaining a hierarchial system of file protection and by enforcing a strict code of confidentiality among LIC staff.

24. A rigorous data back-up regime should be implemented. Suitable equipment should be acquired to ensure back-up operations can be carried out without the need for constant supervision.

25. Data should be stored in manageable and logical units. The temptation to join data files together should be resisted. This will guard against massive data corruption/loss.

26. A system of MASTER/CURRENT labelling should be instigated. All editing should be carried out on CURRENT versions of data files (copies), which should only be elevated to the level of MASTER versions following rigorous checking and verification procedures.

27. A widely circulated data catalogue should be maintained, detailing data available on the GIS.

28. Concerted and continuous efforts should be made to update poor quality data layers (e.g. national lands) by cross-referencing with other, more accurate layers (e.g. land parcels).

Implementation

29. Given the inevitable delay in construction of the LIC building which would accompany acceptance of any funding proposal, a phased proposal should be considered. This might entail funds being made available up-front for a single, suitably configured workstation, which could begin a limited service based upon the work already carried out by Edinburgh University. This would also provide the opportunity for initiation of a limited training programme.

Introduction

The study has been carried out largely in the context of the report by RDA International (1989) into the feasibility of establishing a Land Information System (LIS). While largely concerned with description of a LIS to handle land parcel information, the RDA report identified considerable support for the establishment of a complementary GIS to serve the wider needs of both government and non-governmental organisations. The present study aims to expand on this aspect and to examine, in some detail, the potential role of such a system and identify some of the problems which may be encountered. As well as considering technical aspects, the study also briefly examines the need for instigation of a physical planning structure, seen as a pre-requisite to the establishment of a functioning GIS in Belize.

While it could be argued that the existing sectoral approach to land use planning has functioned adequately to date, the pace of development and the increasing need to ensure that the aims of agriculture, conservation, tourism, forestry and urban expansion are reconciled, will require a more positive and integrative approach to land use planning. This requires integration of data relating to land resources and land use, the technology for which is now available in the form of computer-based Geographical Information Systems.

While there have been numerous abortive attempts to introduce this technology into developing nations before, there are a number of reasons to be optimistic where Belize is concerned. These include data availability, the increasing wealth of computer expertise and training available in Belize, and the relatively non-bureaucratic and informal nature of much current governmental activity – factors which should allow the instigation of a sustainable GIS unit and supporting institutional structure, and accommodate the need for continuous flexibility.

Many of the reported disappointments surrounding the installation of GIS in other countries can be ascribed to the failure to adopt a suitably bold approach to re-organization of planning procedures and institutions. The discussions carried out in preparation for this report have underlined recommendations made in a number of recent studies, namely, that the time is right to carry out such a review.

What is a GIS?

A Geographical Information System (GIS) is a means of storing and integrating data relating to defined geographical locations. Such a concept is not innovative in itself. Maps are complex examples of such systems; often presenting a vast quantity of information relating to variables such as drainage, relief, settlement, communications network and land capability; but there is a limit to the amount of information which can be presented on a single map sheet. Problems occur when it is desirable to relate information held on separate sheets (and often at different scales) and derive answers to specific questions. An example of the type of question which might be posed would be "select areas suitable for a specific crop which have a slope of less than 40% and which are not identified as containing a particularly valuable ecological habitat." This type of operation can now be performed using a computer-based GIS such as ARC/INFO.

Computer-based GIS are now available on small, low-cost computers. Such systems have been widely tested and proved efficient in the integration, storage, manipulation and output of derivative maps. Unlike traditional cartography, GIS allows the user to take a problem-solving approach to the data stored in the system. Research questions can be broken down into a number of stages which can then be seen as a graphic representation of the result of these stages. In terms of physical planning, such a dynamic approach to data allows investigation of various scenarios and the testing of hypotheses at an early stage.

In Geographical Information Systems, data pertaining to different variables, or data layers, as they are termed, are held as separate files, all referenced to a common co-ordinate grid system such as the Universal Transverse Mercator (UTM), or degrees of latitude/longitude. Such systems commonly offer a wide range of functions, perhaps the most relevant in the current context being the ability to perform relational operations between data layers and so produce maps indicating the results of complex queries. Other functions often include 3-D terrain modelling (see front cover), network analysis and, interfaces with other commonly used software packages (databases, statistical packages, etc).

The ability of GIS to integrate data drawn from different sources such as national map series, resource surveys, aerial photography and satellite remote sensing, potentially provides those involved in resource planning with an extremely powerful tool. In the work carried out so far on the GIS for Belize at Edinburgh University, data has been input from the 1:50,000 topographic map series (roads, drainage, settlements), 1:100,000 scale land resource surveys (land systems, land use), census data (1980 Population Census and 1985 Agricultural Census) and satellite remote sensing (vegetation classification from Landsat data). It would prove nearly impossible to comprehend relationships existing between such data layers simply by using maps and photographs.

Data can be input in a number of ways. These include manual digitising tables, photogrammetric plotters, scanners and, by way of direct link-ups with image processing or other computer equipment. Once the data are stored in the GIS we have an almost infinite flexibility and are freed from the constraints of scale and map sheet boundaries. As will be discussed later this freedom is accompanied by a whole range of new considerations relating to data quality, data resolution and output scale. Such considerations are vital if spurious results are to be avoided.

Perhaps one of the most useful developments in GIS, with regard to the needs of developing countries, is the ability to integrate data from satellite remote sensing, particularly for information on vegetation and land use. The ability to draw data layers from a wide range of satellite sensors (those aboard SPOT and Landsat, for example) offers the opportunity to update data periodically at relatively low cost when compared with the standard method of aerial survey and drafting. Updating is achieved by way of a link-up with image processing software which is also readily available on low-priced computer equipment.

The strength of any GIS lies in its ability to integrate data, which was perhaps previously held by separate groups (departments) and in incompatible formats. Once a central database is installed, the ability to draw upon previously unavailable data will greatly increase. To achieve maximum effect it is vital that the technical installation of the GIS is accompanied by the appropriate infrastructural and attitudinal changes. Once jealously guarded sectoral information must come to be seen as part of a valuable corporate resource. This change will not occur overnight but can certainly be encouraged, both by applying certain operational measures and a campaign of education and awareness.

Needs assessment

This section assesses the potential uses of a GIS within Belize. Much of what follows is the result of preliminary discussions with government organizations.

While the areas specified below are wide-ranging, experience suggests these will expand rapidly once the system is installed and its potential demonstrated. The intial role of the system will be to assist in governmental rural land use planning and the assessment of land for development but, as data are added and procedures formalized, it is expected that links will develop both with other sectors of government such as urban development authorities and utilities groups, and with non-governmental organizations; and in time, the role will expand to encompass the private sector. Such expansion should be encouraged, particularly where the process can be seen in terms of a two-way exchange of data and information.

Rural land use planning in Belize

Several factors have emerged with regard to rural land use planning in Belize:

(i) Very little forward planning is attempted, even where statutory bodies exist and have approval to do so. This is largely due to staffing constraints and the dearth of specific legislation and guidelines for planing.

(ii) Planning is primarily exercised through development control, notably concerning subdivision of land, control of forestry activities and, mineral extraction.

(iii) Legislation intended to assist in the planning process is often vague and targetted at inappropriate institutions. The fact that such legislation can be interpreted in any number of ways has only confused procedures and reduced enforcement.

(iv) The particular remit of the various bodies charged with positive planning is ill-defined and overlapping. As such, many of the bodies who could be exercising powers in this area are not doing so.

(v) Current pressure within government is to increase the powers of sectoral planning units. The danger exists that this will lead to a proliferation of committees without the necessary inter-sectoral co-ordination.

The current structures and legislation are inadequate to resolve increasingly inter-sectoral problems. As such, the encouraging moves towards inter-sectoral policies implicit in the rise of eco-tourism, agro-forestry, and forest management/conservation are likely to flounder as the pressure on land increases.

There is a danger that, without a detailed set of policies and priorities regarding land use allocation, development concessions will be granted on land unsuitable for specific agricultural projects and areas of rare environmental diversity will be lost to agriculture or other developmental activities and *vice versa*.

Several recent reports suggest these conflicts can be resolved by the integration of land-related information in a LIS/GIS. It is suggested here, that, while such a system will enhance understanding of such conflicts, and even highlight their existence, without a complementary land use policy and plan and the supporting institutional infrastructure to implement them, little improvement will occur.

It is recommended that a physical planning unit should be established. It would complement any GIS facility, in so far as the GIS could be used to furnish information to facilitate development of a plan, and the planning unit could ensure that requests made of the GIS facility are co-ordinated and to some defined end. The possible linkages between such a unit and the GIS facility are discussed in greater detail later.

How should a GIS be used?

Discussions have shown that much of the information required by interested parties can be drawn from the same basic data layers, which is encouraging, as it suggests that a great deal of use can be made of the finite amount of data currently available for Belize. This section briefly examines some potential uses of the GIS, albeit only a small fraction of the potential applications areas. Examination of these areas has undoubted impact on the necessary structure and linkages discussed later.

Physical planning

One of the primary roles of the GIS would be to furnish information to assist in the physical planning process. The existence of a centralized store of information relating to land resources and land use will facilitate the formulation of land use zones and the eventual creation of a national physical plan.

If maintained and updated regularly, the GIS will allow for a dynamic physical planning process which can operate in two principal ways:

(i) *The impact of various strategies can be assessed at the planning stage* For example, where land is required for the expansion of agricultural activity, perhaps around a particular settlement, is the land immediately next to the village agriculturally suitable for a specific cash crop? Are these areas of specific ecological importance? Are they too steep to allow sustainable milpa activity?

Other obvious examples concern the provision of infrastructure. Is a new road going to pass through any protected zones? Will it pass through any areas of wetland where specific engineering problems may occur? What is the best route for such a road given the wish to avoid certain features?

(ii) *Monitoring the impact of existing policies and plans* Are farmers being forced to clear areas unsuitable for staple crops? Is urban expansion threatening coastal protection? Where is soil erosion occurring?

The ability to assume such a dynamic approach to data will facilitate more regular review of policies and plans than is often the case.

The GIS should also allow the delineation of land use zones. This procedure is essentially the overlay of any number of data layers in accord with a set of pre-defined priorities. Again, a dynamic approach can be adopted.

As will be described later, one of the main advantages of using a GIS as the foundation for the physical planning process is that it facilitates consultation. Draft maps of various scenarios can be produced and circulated within government and non-governmental organizations.

Development concessions

The GIS will allow determination of whether a particular development plan is suitable for the particular plot of land suggested. Is the soil capable of sustaining the proposed crop? How much new road will be required for access? Does the area include any archeological remains?

Again, the ability to circulate drafts of areas under consideration will revitalize the statutory inter-sectoral consultative process.

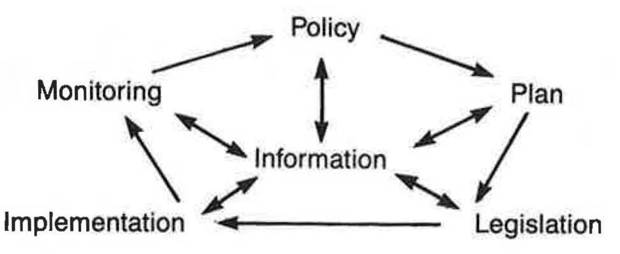
Information for policy makers

The GIS will be able to provide several levels of information to policy-makers. One of the major impacts will be highlighting land use conflicts between sectors. As such, the need for policy guidelines and legislation will become evident. It will be possible to investigate the spatial impact of proposed, and on-going, policy measures and to quantify these changes in terms of land quality and their effect on existing land use.

The primary channel between the GIS and policy-making bodies should be via a co-ordinated planning unit. Such a hierarchical structure and the existence of an effective information base, will enhance the formulation of policy and its effective implementation.

Figure A18.1

The central role of information in policy making



Information for non-governmental organizations

Aid agencies and non-governmental organizations, such as universities and conservation organizations, should be encouraged to request, and be instructed to supply, information from/for the GIS. Such requests can be tailored specifically to their needs. Where possible, collaborative ventures should be encouraged whereby such organizations agree to swap data collected as part of their operations for any assistance given.

Information for the private sector

As it develops, the GIS will become the most comprehensive data source available for Belize. Private investors and companies investigating the possibilities of investing in Belize will desire access to this information. The scope of such demands could range from simple land suitability maps of areas under investigation through to large-scale survey and mapping projects undertaken for major commercial concerns (e.g. oil companies, agricultural projects). While such work should be approached with care, especially with regard to data security, it should generally be encouraged, especially if a suitable pricing structure can be arranged later.

Information for agricultural extension

Agricultural extension officers have been hampered in their duties both by a lack of access to basic maps of their respective zones and to mapped soil and suitability data. Further, the experience accumulated by extension officers concerning the land characteristics in their zone and its use for agricultural purposes is requently lost when they move to a new area or occupation.

A particularly innovative and practical application of the GIS has been suggested (R. Barrett, 1989, personal communication), whereby extension officers are supplied with maps of their zones showing roads, drainage, settlements and soil characteristics or reported suitabilities for crops. The maps could be produced at such a scale that the zone occupies the whole sheet. The extension officer would be encouraged to annotate these maps (or clear overlays) with his impressions of crop response and soil characteristics. Training courses, designed to instruct officers in the interpretation of soil and suitability maps and in basic soil sampling techniques, have been undertaken.

If carried out regularly, this application would lead to increased knowledge and understanding of the often subtle variations in soil characteristics and their relationship to plant growth. Over time, documentation could be used by specialists to re-interpret and refine existing soil and land suitability maps. Such an iterative approach will dramatically improve the effectiveness of the extension service and understanding of the land.

Information for urban planning and utilities

While it is likely that the initial applications of the GIS will arise from those concerned with rural areas, the use will probably expand to accommodate urban planning and utility (electricity, sewerage, etc.) projects, which will use scales of 1:10,000 and larger; and require a considerable amount of the detail which already exists in the GIS. Many applications will require access to parcel boundaries from the LIS; and projects will tend to be localized.

For all these reasons, the initial use of the GIS/LIS facility for urban/utilities projects will probably involve considerable data input. Attention must be paid to the future use of this data. Where the data are only likely to be used once the project should be discouraged, but where a particular street plan or utilities map could be used in future planning work, then the project should be seriously considered. Considerable care will be needed to avoid overlaying large- and small-scale data, and to base planning decisions on the result (see later).

Can a GIS be made to work in Belize?

There are a number of reasons to suggest a national GIS facility is a practical possibility.

(i) *Manageable problem* The relatively small land area of Belize with an area of approximately 8855 mi^2 (22,934 km^2), is covered by forty-four 1:50,000 map sheets. In terms of the use of satellite data and most conceivable digitising tasks the facility could operate with a relatively small computer system and staff.

(ii) *Data availability* Belize will soon have access to a recently updated 1:50,000 topographic map series.

Belize now has a complete set of land resource surveys providing data on soil characteristics, land suitability for specific crops, limitations to cultivation, land use and recommended land use.

A number of satellite images (available as far back as 1974) already exist for Belize. If analysed using image processing software, such data will provide the basis for a number of database layers, notably land cover and land use. New images could be acquired on a regular basis in order to monitor change over time.

The considerable amount of both academic and consultative work regularly undertaken in Belize should be entered into the GIS, which should allow integration of detailed local studies with national datasets.

(iii) *Availability of expertise and training* The amount of technical expertise available within Belize has improved rapidly in recent years. Computing has been added to the high school curriculum, and computing equipment is appearing in offices and educational establishments. Several private firms have been established to supply computing equipment. They have increasing access to technical support staff and hardware and software maintenance and provide training courses. Further, within government itself, the level of knowledge concerning computers and their applications is continuing to spread; recently extending to the interpretation of satellite images. Finally, companies such as Belize Sugar Industries are currently making use of GIS-related technology in everyday applications.

(iv) *Lack of existing bureaucratic apparatus* The current lack of entrenched planning structures and rules governing data ownership can be seen as an advantage. The informality of much current decision-making and consultation and the relatively low levels of bureaucracy should make implementation of both the GIS and any supporting structure far less dramatic than might have otherwise been the case.

(v) *Proximity to the USA* The relative proximity to the USA and to companies who would provide technical support to a GIS facility (e.g. ARC/INFO is supported by ESRI of California), should mean technical support and maintenance are provided much as they would be anywhere in the United States. This is undoubtedly improved by the increased access to communications technology in Belize, especially FAX machines.

(vi) Existing GIS – A research project, funded by NRI, has been examining the potential of GIS to handle land resource survey data. The project, within the Department of Geography of Edinburgh University, has involved input of the Toledo (King *et al.*, 1986) and Stann Creek (King *et al.*, 1988) land resource surveys and several other data layers (drainage, roads, settlements). Subsequently, the land resource survey data of the rest of the country, taken from the present study and Jenkin *et al.* (1976), has been entered into the GIS, which is already in such a form that if downloaded to Belize, it could immediately provide information of practical value. The considerable delay normally associated with attempts to begin the database construction from scratch will not apply.

Data availability

National datasets

The list of available national datasets shows extreme variations in scale and quality. For example, national lands are only mapped at a scale of 1:250,000. The following datasets are mapped:

(i) Soils (Wright *et al.*, 1959, Jenkin *et al.*, 1976 and current NRI surveys)
(ii) NRI land resource surveys (1:100,000) – land suitabilities
(iii) Drainage (1:50,000 topographic series)
(iv) Road network (3 classes – 1:50,000 topographic series)
(v) Elevation (1:50,000) (can be used to indicate slope)
(vi) Land use (resource survey, satellite imagery and ground observation)
(vii) Land ownership (1:250,000 property map)
(viii) Designated areas (1:50,000 – forest/wildlife reserves)
(ix) Land cover (vegetation – satellite imagery, FAO project)
(x) Settlements (1:50,000 topographic series)
(xi) Census enumeration zones (forthcoming – 1:50,000)
(xii) Archaeological sites

Local datasets

The primary source of new datasets will probably be localized studies, which must be accommodated in the GIS in such a way that their long-term use and compatibility with future surveys is maximized (see later). The sources of such local studies will be varied – ranging from academic studies, consultant's reports and work carried out by aid agencies. These studies are vital in so far as they often update older national datasets, but while such studies should be catalogued, actual digitising of mapped data should be resisted until a need can be demonstrated. It is especially vital, in this context, that the points mentioned later concerning data quality and the need to document data sources are adhered to. It might also be useful to consider issuing guidelines to undertake surveys, including specifying the base maps to be used for recording data to specific classification schemes or even, areas of the country where such survey work would be of most benefit to Belize.

A Land Information Centre for Belize

The recommendation, made by RDA International (1989) that a separate Land Information Centre be established in Belmopan is endorsed. A centre is necessary for a number of reasons, principally to co-ordinate data manipulation and the need for space requirements and the necessary technical infrastructure, such as electricity, back-up generators and air-conditioning.

It is also important that the system is seen to be a government-wide facility. If located within the confines of any particular ministry, or perceived to be the property of any one ministry, the potential for the GIS to serve the wide needs of government and to gain access to data would be reduced.

Possible structure of an LIC

While accepting that it is vital that the LIS and GIS are completely compatible and linked, they will ultimately be serving different needs and user communities. The LIS will, by its very nature, be of value to the Lands and Surveys Department of the Ministry of Natural Resources. Given the confidential nature of its contents, its use outside the confines of land registration and taxation will be limited. This is not the case with the GIS. As mentioned above, it is vital that the system is accessible to a wide user group, encompassing both governmental and non-governmental organizations. While it is accepted that the GIS should, like the LIS, be ultimately responsible to the Ministry of Industry and Natural Resources, the tasks and priorities of the GIS and LIS facilities will differ to the point where a separate GIS division within the Land Information Centre can be justified.

It is also suggested that one of the main areas of GIS activity will concern data relating to the environment and conservation. The proposed Conservation Data Centre (CDC) would form a convenient sub-division of the Land Information Centre. Private sector support for the centre has been identified and trained staff would be provided.

The recommendation that Mr. Lindsay Belisle be named as overall director of the Land Information Centre is endorsed. It is also suggested that the post of GIS project manager be created. He/she would provide the necessary linkage between the GIS division and the user community.

The technical configuration of the LIC is discussed in more detail later, but the network of powerful graphics workstations, as recommended by RDA International, would provide the ideal basis for the facility. Such a configuration of LIS, GIS and CDC all linked to a central database and sharing standards concerning co-ordinate systems and data quality, would provide a facility, and the opportunity, largely unsurpassed elsewhere in either the developed or developing world.

In the discussion that follows, estimates of computing equipment and staffing are seen as minimal to the success of the facility. These initial levels would be expected to rise as demand increases.

The GIS division of the LIC

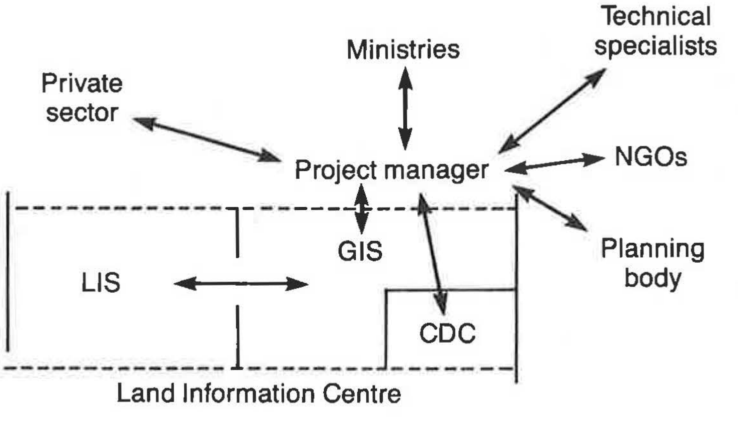
Accepting the technical configuration supplied by RDA International, the minimum amount of equipment necessary for the functioning of the GIS division (not including shared equipment) would be two graphics workstations, two non-graphic terminals and two digitising tables. The Conservation Data Centre would probably require an additional workstation and digitising table.

The GIS project manager

There should be a GIS project manager directly answerable to the director of the Land Information Centre who would act as the contact between the outside world and the GIS division. The GIS project manager would liaise with all bodies making requests for GIS products. She/he would be required to translate requests into GIS operations and to assign staff and equipment to individual projects.

Figure A18.2

The role of the project manager



The Project manager would initially translate requests into three headings:

Output requirements – scale, topographic detail
Data requirements – new data to be digitised
GIS operations – which data layers to be involved, which GIS operations to be carried out?

This process could be formalized, to an extent, by requiring requesting bodies to specify their requirements on a standard application form. The project manager would interpret these requests and return estimates of time required (and cost) for the operation.

In time the responsibilities of the project manager may need to be delegated to other staff, possibly with a separate deputy assuming control over certain sectors (e.g. CDC). The role of project manager is discussed further on p.504.

Conservation Data Centre (CDC)

Several reports have identified a need for a Conservation Data Centre (CDC) to collect, catalogue and supply information relating to the biological diversity of Belize. The data would be used to formulate policy relating to the environment. Located in Belmopan, the centre would encompass a catalogued collection of printed material, a map room and drawing office and computing facilities. Within the wider aims of the centre, the input of spatially referenced material to a GIS is envisaged.

Preliminary discussions have taken place with the "Programme for Belize", who suggested they would endorse and support the GIS component of the CDC being located alongside (i.e. in the LIC), and made compatible with, the wider government GIS. Further, support for the equipment, staff and training of such a sub-division has been offered. Integration of the environmental data which will accrue as part of the wider CDC project will benefit all users of the GIS division. Integration of environmental data with other data layers stored in the GIS would, in the first instance, assist the formulation and harmonization of forestry and conservation policy, as well as wider planning applications.

Co-operation between the GIS division and the CDC sub-division would also produce other benefits, e.g. if the CDC decided to undertake a forest inventory of a particular region, perhaps using satellite remote sensing data. Such an inventory is time-consuming and requires considerable knowledge of the vegetation within an area, but specialist information would be readily available to the staff of the CDC. Once the classified data were available it could be used for other applications and assist in the production of an updated vegetation map of Belize. Similar co-operative ventures can be envisaged and should be encouraged.

Linkage with government

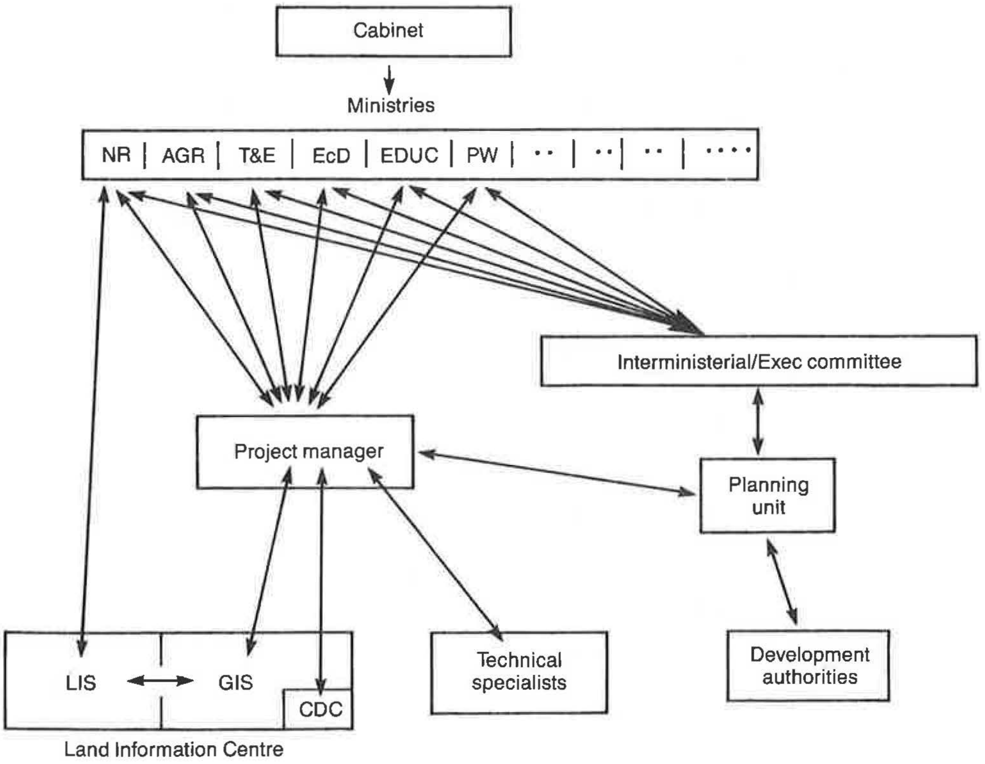
This section examines the relationship between the proposed LIC and government. There are several key points to note:

(i) The need for a high-level inter-ministerial land use committee, recommended by RDA International (1989). The committee should consist of permanent secretaries or their representatives and other relevant individuals charged with determining policy guidelines for rural planning and who would instigate leglislation to assist policy implementation;

(ii) The need for a National Planning Unit, which would be responsible for turning policy guidelines into plans. The unit could be staffed by planning officers appointed from sectoral planning units.

Figure A18.3

Possible position of a LIC in government



(iii) The Land Information Centre would be responsible for providing information requested by the planning unit, and could be consulted directly by ministries. This acknowledges that the GIS will be used for tasks outwith physical planning.

(iv) The technical committee recommended by RDA International is considered unnecessary at this time. Many of the tasks envisaged for this body could be performed by the planning unit. True technical liaison, where this refers to specific questions concerning the various specializations involved, (e.g. soil science, archaeology, etc.) could be handled by the GIS project manager. There are a number of reasons why this liaison should take place on a purely bilateral and informal basis:

(a) The technical specialists are already required on a large number of committees;

(b) Many would have to travel considerable distances to attend;

(c) Technical questions will probably be highly specialized and sporadic. For example, little would be gained from having a tourism specialist present at a meeting discussing soil suitability.

Linkages with non-governmental organizations

There are a large number of non-governmental organizations which will probably be supplying data, much of which will come from detailed localized studies, possibly of soil conditions, bird habitats, tourist numbers, etc.

Linkages should be developed to these organizations with the intention of both receiving and supplying information regarding their specific fields of interest. Ideally, these linkages should be via co-ordinating committees such as the National Conservation Advisory Board or the Belize Tourist Industry Association. Efforts should be made to establish national standards and classification methods, so that data collected by discrete groups (e.g. university expeditions, ornithologists, aid agencies) are linked together into national datasets. Over time these datasets would increase in detail and spatial coverage.

Linkages with the private sector

There are a number of reasons why the GIS division of the LIC should be able to accept outside contract work:

(i) The recurrent costs of operating the facility can be partially offset by contract work;

(ii) The GIS will rapidly become an extremely valuable resource and one which could provide an unrivalled service for commercial and non-governmental organizations operating in Belize;

(iii) Agreements can be reached whereby commercial companies and non-governmental organizations provide data in return for services rendered.

Contract work should be charged, either on a flexible pricing scale, or on the basis of access to reciprocal data deemed valuable to the longer term development of the system. Examples of such agreements might include mapping from remotely sensed data for large commercial concerns (such as Belize Sugar Industries), where agreement is reached with them to supply Landsat data regularly; or investor requests for environmental impact assessments of their activities.

Opportunities for contract work will probably range from simple provision of maps to investors to large-scale survey operations. Where work is charged, considerable flexibility should be exercised. Charging should not necessarily be undertaken with a view to recovery of full data entry costs, unless a large amount of new data input is required.

Care will be needed to ensure access is only given to data layers holding 'open access' status, or where prior arrangement has been made with the 'owner' of that data. The question of data security is dealt with more fully later.

Care must also be taken to ensure contract work does not detract from the everyday operations of the division. This can be partially achieved by employing temporary labour (e.g. college students during the vacation period) to undertake digitising and other simple tasks. Data input for such work should adhere to the guidelines specified earlier regarding long term use and data quality. These are discussed further later. Provision should be made for funds raised in this way to be used to fund recurrent costs such as maintenance, paper and pens.

Linkage with the proposed LIS

The RDA International report identified that the true potential of the LIS/GIS facility will arise from the ability to integrate detailed land parcel information (via the LIS) with thematic data held in the GIS.

An obvious example of such integration is where an investor is interested in a specific plot. He will be able to investigate this plot in terms of its land capability, proximity to water, access, potential for expansion, and so on. The converse is perhaps just as interesting, in that an investor will be able to specify a particular project and then identify parcels which fulfil his criteria and which are available.

While it is relatively easy to identify any number of useful applications, these must be tempered with a degree of caution. Firstly, data must be treated at an appropriate scale. The land resource survey data collected by NRI is not detailed enough to be used as a definitive guide as to the crop potential of a small land parcel. It does however, indicate a range of crops which are most likely to succeed.

A further consideration will be data security. While the link between the GIS and LIS will be mutually beneficial, care will need to be taken to ensure that personal information associated with land parcels is not disclosed. This can be easily achieved by simply passing boundary polygons into the GIS without any personal details being attached. A converse situation might occur when census data are involved.

Given these reservations however, the prospect for an integrated LIS/GIS is good, especially when we consider the potential which exists to integrate parcel information with satellite remote sensing data to indicate past and present land use.

Technical considerations

This section describes the minimum technical requirements of a GIS division within a Land Information Centre. The configuration is discussed in the context of the RDA study. Far greater consideration of these technical matters will be required if plans for the LIC are to proceed.

Whatever equipment configuration is finally decided upon, it is vital that both hardware and software maintenance is budgeted, and seen as a significant recurrent cost.

Software

Without wishing to re-iterate the reasons stated in Appendix E of the RDA International report, it is important to confirm support for the selection of ARC/INFO as the software which will support both the LIS and GIS.

ARC/INFO software is most suited to handling large datasets, particularly where resolution (accuracy) is important, as in the LIS. Equally as important, this GIS software is the most widely used in the world for such applications and its functionality is likely to increase, particularly into areas relevant to this project – notably, interfaces to relational database software and raster-based systems (e.g. ERDAS).

In addition to ARC/INFO, the GIS division would require, in the first instance, the ERDAS image-processing software, MINITAB, the statistical analysis package and programming language compilers (e.g. FORTRAN or PASCAL). Access to a word processing package (e.g. Word Perfect) would also be useful.

In the longer term, acquisition of a powerful relational database system such as ORACLE should be considered. ORACLE can be interfaced with ARC/INFO and graphics packages such as GIMMS, and provides excellent report writing and statistical functions to assist in the analysis of large datasets, which would be particularly useful if census analysis or land use breakdowns are required on a regular basis.

Hardware

Before considering any particular hardware configuration, it is important to specify the particular minimum technical requirements for a Land Information Centre LIS/GIS:

(i) Powerful single-user processors e.g. workstations;
(ii) Expandable network capability;
(iii) Central data storage/fileserver;
(iv) Central back-up capability;
(v) Multi-process capability on workstations;
(vi) Layered file protection capability;
(vii) Secure password capability.

The task of matching these specifications to actual products is beyond the scope of this provisional report. The recommendation made by RDA International that the system should be based around powerful graphics workstations fulfills the first four points listed above. Further investigation will be required to determine whether such a configuration fulfills all the required criteria.

Assuming a hardware configuration similar to that recommended by RDA International is found to be appropriate, the following set-up could be envisaged for both the LIS and GIS divisions and CDC sub-division:

(i) AO digitising tables probably attached to non-graphic terminals. There is no real need to have a graphic workstation tied up by digitising. The non-graphic terminals would be run from the graphics workstations providing these have multi-process capability.

(ii) Graphics workstations used for editing, coding and map composition, requiring considerable local disk storage.

(iii) A central file-server high density (6250 b.p.i.) tape drive and attached systems terminal. This would be used for file and tape management operations.

(iv) A 132 character line-printer for text output

(v) An AO eight-pen plotter

(vi) A4 ink jet plotters (e.g. paintjets) for easy screendumps

(vii) A laser printer for high quality graphic and textual output.

Plotters, printers and disk storage would be shared with the LIS division and CDC sub-division. One of the workstations should be configured to handle the ERDAS image-processing software, which will require the appropriate graphics card and a high resolution colour monitor.

Staffing the LIS

Given the need to ensure that all equipment is used to its full potential, the LIS could accommodate at least 10 full-time staff in the suggested scenario. Initially, these individuals will probably be allocated as follows:

(i) 2 persons – map preparation/output production/checking;
(ii) 4 persons – digitising (on digitising tables);
(iii) 4 persons – editing/coding (on graphics terminals).

Where the LIS is concerned, staff currently employed in the drawing section of Lands and Surveys could easily be moved into digital operations. All staff must be trained in all stages and must be rotated among tasks to avoid tedium.

This assumes that the principal task for the LIS for the foreseeable future will be data input and checking. Once the LIS comes on-line – is used for the everyday tasks of the Ministry, then we could expect at least two of the staff to be moved to carrying out requests for information and writing command procedures.

Staffing the GIS division

The staffing of the GIS division is more problematic. Taking the scenario where the division begins with two workstations and two digitising tables, four full-time staff would be needed. One of these would be the project manager. The other three members of the GIS division should be selected from backgrounds ranging from computing/statistics to agriculture (and any other applications area). Such a mix is considered vital.

There should also be an arrangement whereby individuals temporarily seconded from various ministries can become involved with data input in connection with any specific project. This has a number of benefits, not least of which is the freeing of GIS division staff from time-consuming data input. It will also allow the requesting body to keep tight control of data quality and, to feel involved in their project. Individuals seconded in such a way should either have attended a training course or accept that their role in the project will be limited to what can be easily demonstrated in a short time. It has been noted during discussions with several government departments that a considerable number of staff have undergone training in computing, primarily as it relates to their specialization. More recently, two separate groups have received basic training in satellite image interpretation in the context of projects sponsored by the FAO and USAID. Such a body of skilled personnel should be drawn upon when the time comes to staff the GIS division.

In the longer term, the prospects for continued staffing are bright, with computing having been added to the high school curriculum. Considerable efforts should be made to attract this talent into the GIS unit. It may even become feasible to introduce a GIS/Remote Sensing option as part of a degree course at the university or technical college.

Staffing the Conservation Data Centre

While this unit will be a sub-division of the GIS division, it will also represent the GIS component of the wider Conservation Data Centre, funded by the Programme for Belize who have given an undertaking to train staff in research techniques and to make them available for GIS training. There is considerable advantage in having such individuals, skilled in the wider issues of conservation and environmental management, as operators of the CDC subdivision. They would be fully supported by the Programme for Belize.

Technical support

Access to someone who can manage the computer hardware is essential. She/he may be somebody who already works in the government computer centre, but she/he will be responsible for daily back-up operations, general maintenance, upgrading software, tape management, assisting with data and other technical problems. Ideally, she/he should be acquainted with the operating system, computer programming and the GIS/LIS software package. It is expected the position will rapidly become full-time. Failure to identify someone will likely lead to hours (or even weeks) of needless down-time. She/he should be considered for short overseas training courses.

Training

The training component of GIS installations is usually underestimated. The successful construction and operation of a GIS is not simply a matter of understanding one particular software package.

The first step in any training programme should be instruction in the computer hardware and the operating system, supplemented, if possible, by introduction to other software such as word processors, programming languages and graphics packages.

An intensive one-week, or two-week, training course in ARC/INFO is probably only sufficient to provide the basics. If we take the analogy of learning to drive a car. Simply passing a test after some lessons does not make you a competent and safe driver. Like driving, the only way to master ARC/INFO is through practice and experience. In particular, training courses and manuals are inadequate:

(i) When things go wrong (as they frequently will);

(ii) When we want to know the most efficient way to do a particular operation.

While these can be learnt over time, many of the pitfalls can be avoided through an incremental training course. Especially in terms of GIS, staff must be trained in several vital areas:

(i) General GIS theory – different approaches to digital data;
(ii) Problems of data quality;
(iii) Database design;
(iv) Construction of command procedures;
(v) Organizational and managerial issues.

Besides ensuring spurious results are not produced and that the GIS is constructed and maintained in the most efficient manner, training will turn what can be seen as a fairly mechanical, mundane job, into a more interesting and challenging one.

The most appropriate approach to training is to instigate a continuous training programme in the context of the GIS/LIS facility. The programme should consist of lectures held at set times each week. They would be compulsory for permanent staff, while attendance from other ministries would be for those who either have a specific interest, or who are likely to be seconded to or liase with the facility. The sessions can be structured to move through general considerations to technical issues, and non-facility staff could attend those sessions considered appropriate.

The regular lecture course would be supplemented by practical computer sessions followed by informal tutorial discussions. In this way, staff could be led through the various stages involved in GIS operations, adding new commands each week and experimenting during the practical sessions. The training course could take a worked example (perhaps a particular part of Belize) and follow the procedures through map preparation, digitising, editing, checking, coding, GIS data manipulation and, map output. The advantage of such an approach is that problems could be sorted out in a controlled way and not during the normal working day on 'real' data.

To this end, it is recommended that, following approval by the funding agency for implementation of the proposal, an individual should be brought in to train the staff of the GIS/LIS facility, to oversee installation of the computer system and software and the down-loading of the existing database, and to begin formalizing the operational procedures outlined above. Ideally, this individual should assume the role of project manager during the overseas training period of the full-time project manager. They should then have a short familiarization period when they operate side by side.

Training the GIS project manager

As discussed earlier, this position is the vital link in the structure. She/he must be able to understand the wider aspects of GIS. She/he must be able to assess the time/cost requirements of a user request, and a nonsensical or inappropriate one! She/he must be able to assess the most appropriate approach to a problem, design the database structure, assign staff and equipment between various projects, and justify her/his decisions to her/his superiors. At the same time, she/he should be diplomatic and technically proficient. Overseas training in GIS will be necessary. Funding for the training could be sought from the British Council and a place on a 12-18 month course could be booked. Training decisions would need to be taken before March of the year during which the course is to begin.

Awareness workshops

Policy making and planning staff should also be instructed about the potential and limitations of the new GIS facility, thus hopefully ensuring appropriate expectations and avoidance of some of the disappointments. A widely advertised workshop could be held in the early stages of implementation. It should begin with a presentation including: What is a GIS?; Why a GIS is not just map-making; What can be expected from the GIS; What it can expect from the GIS; What it can expect from the operator. The workshop would cover some of the general points made in this report and begin the process of widening the use of the GIS both within government and outside. It will depend on the configuration of any revised planning structure, and should allow time for questions and comments from the floor.

Operational considerations

There are a number of considerations necessary to maintain the security and integrity of the data held in the LIS/GIS.

Data

One of the major differences between GIS and traditional cartography is having to consider data accuracy which must effect our use of the data in GIS operations and output. Accuracy is especially important when linking high resolution LIS data with the often low resolution thematic GIS data layers.

There are a number of ways to avoid this type of problem. This section examines some simple procedures which, although they do not totally absolve the operator from responsibility, will limit the potential for disaster. It should be stressed that time and effort spent at the input stage will pay long term dividends and should not be compromised, even though this will delay actual progress towards output. While in manual cartography, the cartographer can produce output rapidly, in GIS, it may take up to 80% of the total period to input and check the data before any output is contemplated! Understanding of this by those requesting GIS products will help detract from any feelings of impatience or disappointment.

Input

The often-quoted maxim 'garbage in, garbage out' is particularly apt in GIS. Error can occur in any number of stages; the original maps can contain cartographic errors; the maps can become physically distorted; the digitising may have been poor; and coding errors could have occurred. Errors at any or all of these stages may not show up in any GIS output and may even be further complicated during overlay procedures, but certain procedures can be undertaken to minimize these problems:

(i) Use new copies of maps where available;
(ii) If possible use original separates/stable medium copies;
(iii) Never use folded maps;

(iv) Take data from the largest scale map available (e.g. 1:50,000);
(v) Check map dimensions;
(vi) Work to rigorous, pre-defined digitiser tolerances;
(vii) Rigorously check digitising and coding against the original;
(viii) Refer any errors in the original back to source.

All data input should be documented. The source, medium, scale, digitiser RMS error, digitiser tolerances and any problems or noted errors should be recorded in a log, which can be used to temper the use of the data layer.

The use of pre-classified data

Pre-classified data have been mapped according to some pre-defined classification. Examples include land system maps, satellite image classifications and soil maps. The use of such data in GIS operations required knowledge about the classification methods used, the level of survey accuracy and the consequences for output.

Land systems represent recurring patterns of vegetation, soil and landforms. They have been mapped in Belize at a scale 1:100,000. If larger scales are used for output, it must be made clear that the boundaries are only accurate to a scale of 1:100,000.

The attribute files associated with the land systems and their subunits, should not only contain the crop suitability classifications, but should also contain the basic land quality classifications (e.g. soil depth, moisture availability, nutrients, slope), from which the crop suitability classifications were derived. The land quality data can then be used to re-classify the data whenever necessary, e.g. in order to determine the suitability of a new crop.

It should also be appreciated that unedited computer-processed classifications of satellite imagery are usually notoriously inaccurate. Any such classification must be tested against ground information.

Long-term use of data

Given the time and cost overheads associated with data input, any requests requiring data input should be considered carefully before any digitising takes place. Many GIS installations elsewhere in the developing world have failed largely because they have launched into massive data input programmes with little or no idea as to the output required or the longer-term applicability of the data.

All requests made of the GIS will need to be justified in terms of the precise output required and the reusable nature of any data input. This is particularly relevant for local studies, which must be input in such a form that the data are likely to find applications among other GIS users, and are most likely to be compatible with existing or future surveys. Requests which do not justify themselves adequately will tend to be accorded less priority than those which come with a detailed specification.

Data security

In any integration of data previously held by disparate groups, there are bound to be concerns regarding data security. They are compounded when all the data are held in a central database. There are several steps which can be taken to ensure that data does not fall into the wrong hands:

(i) Restrict the amount of information held in the database. For example, fears concerning archaeological artifacts can be overcome simply by holding the location of a site with a minimal amount of associated data. This will still ensure that a site is registered in an area or land parcel, but will not compromise the site in terms of its artifacts or relative importance.

(ii) Enforced protection – The computer system selected must have facilities for the designation of protection levels. In this way files can be restricted to a particular group of users (each of whom will have a unique password). Frequently, such systems allow that a user be granted 'read', 'write', 'edit', or, 'delete' access to a specific file. Translated into logical groupings we might wish to classify data accordingly:

Individual	– only accessible to 'owner'
LDivision	– LIS or GIS division staff only
Departmental	
Ministry	– accessible to a group of individuals
Government	
Open	– accessible to anyone

These protection levels will govern the availability of a particular data layer for inclusion in any GIS operation. Arrangements can be made for appeals against a set level of protection.

(iii) Limit the size of the Land Information Centre. All LIS/GIS activities could be maintained within the confines a single building. Desk terminals in outlying ministries of districts could be restricted. Besides relying on stretched communications links, network proliferation increases the potential for data corruption and security violations.

(iv) Insist on confidentiality among staff employed in the facility. A disciplinary code, similar to banks, may be necessary.

Data back-up

The LIS/GIS must be protected by a rigid back-up regime, involving the regular copying of all data held in the central database to back-up tape. Both the LIS and GIs divisions of the proposed LIC will rely heavily on consistent, reliable back-up of data. Even given controlled and regulated electrical and atmospheric conditions, full back-ups should be carried out every evening. This will require a high-density tape drive (6250 bpi) or video-tape storage device, which can store large quantities of data and do not require constant attention by the system manager. A publicised back-up regime should be maintained. It might consist of storing back-ups for every day of the current working week, the Friday evening of the preceding week and the last Firday of the preceding months etc. Such an arrangement minimizes the chances of complete loss of data while reducing the cost of tapes and storage space. Archival material should be stored in a separate building from the computer system, in case of fire.

Data currency

The ARC/INFO software only allows a single person access to any particular database layer for editing at any one time. This has two main implications in a networked system like that proposed for Belize:

(i) Database coverages should be stored in manageable units (such as RIMS or district/mapsheets). The temptation to join coverages into single units should be resisted. A 'tiled' approach is safer, given the potential for corruption of any particular layer.

(ii) The database should be managed in such a way that a MASTER copy of each database layer or RIM is maintained on the central file server. Editing should always be carried out on a copy of this file. This CURRENT version should be copied on to the workstation disk used in the editing. Only once all editing is finished and the file is thoroughly checked and verified (and topologically 'cleaned') should it assume the status of MASTER version. If organized in conjunction with a rigorous back-up regime, this will insure against corruption of master copies.

Data catalogue

Given the intention to encourage the use of data held in the GIS for planning decisions, a detailed data catalogue must be maintained and published at regular intervals. It might usefully appear as part of a newsletter. The catalogue would detail the contents of the GIS, the area coverage of data layers, owners, permitted access groups, restrictions on output scale, etc.

Data update and maintenance

The data in the GIS must be kept current – achieved through linkages with the organizations equipped to collect the primary data. Further, concerted attempts should be made to upgrade certain layers from the level at which they were first digitised. This is particularly relevant for coverages such as forest reserves and national lands where the exact UTM co-ordinates should become available as the Land Registration Programme and surveys continue.

Day-to-day operations

While day-to-day operations of the LIC will assume their own pattern, there are a number of points which can be made:

(i) Flexibility – While the LIC may physically be split into divisions and subdivisions, everyone will make use of the same file storage. Consequently, an operator from the LIS could, if necessary, use one of the GIS workstations if it is not already in use. Rules will develop to assist in this type of approach – e.g. if a GIS operator wanted the workstation, the LIS operator would be required to finish his present task and hand it over. It is important that all equipment is used as efficiently as possible.

(ii) Division of labour – The best approach to data input is to assign an operator to follow a particular dataset from map preparation, digitising, editing and coding to output/checking. Errors should then be identified and corrected, as well as maximizing job satisfaction and minimizing boredom.

Implementation

This appendix has been largely based on the RDA International (1989) report recommendations, and we generally agree (pending investigation) the computer equipment (both hardware and software).

There are however a number of arguments for a phased introduction of GIS facilities. Such a facility of, for example, a suitably configured workstation, A4 plotter and digitiser could begin not only limited service to the government, but also form the basis for a preliminary teaching course. In this way, the LIC staff could enter the newly constructed facility with basic training in LIS/GIS procedures. The data currently housed in NRI could be down-loaded at any time. The workstation could be located in an air-conditioned room within the Ministry of Industry and Natural Resources (the drawing office?).

Funding and budgetary considerations

Any funding proposal must include not only capital start-up costs for the LIC but also recurrent maintenance costs for at least five years. These costs will be significant and possibly crippling to a fledgling LIS/GIS facility. In the longer term, at least part of these costs should be recoverable via outside contract work.

While falling under the remit of the Ministry of Industry and Natural Resources, the GIS should be funded centrally or from contributions from all ministries who may make use of such a facility.

APPENDIX 19 CURRENT STATUS OF THE GIS FOR BELIZE

This appendix briefly describes the research undertaken with regard to the GIS for Belize. All the work has taken place within the Department of Geography of Edinburgh University (Scotland). It was initiated by NRI and built on experience gained in Belize by the department during the past 25 years. Prior to the NRI project, much of the research carried out in the department centred on analysis and mapping of the 1985 Agricultural Census (both Registration and Full phases), which has been extensively used in undergraduate teaching programmes and as the basis for research papers.

The initial research phase of the NRI project (October 1988 – February 1989) involved an investigation into the potential for GIS to handle land resource survey data of the kind collected for Toledo District (King *et al.*, 1986). It became apparent that the GIS could usefully manipulate such data, while maintaining all the necessary information from the original survey.

The output from the system consisted of land suitability maps (for specified crops), land use maps (1970 and 1985), recommended land use maps, and land limitation maps. These could be produced at any specified scale although general agreement was reached that it should be limited to 1:50,000 and less.

The GIS has been constructed using the UTM grid (zone 16) and all co-ordinates are consequently stored in metres, allowing detailed calculations of areas, distance etc. The tic reference points used to register different data layers are the sheet corners of the standard 1:50,000 scale topographic map series (Figure A20.1). The area of the map accords with 15 minute by 15 minute of latitude/longitude and this allows output of data in a form compatible with the 1:50,000 series. Such a tic grid is essential if data layers are to be constructed from map sheets or local surveys (see Appendix 20).

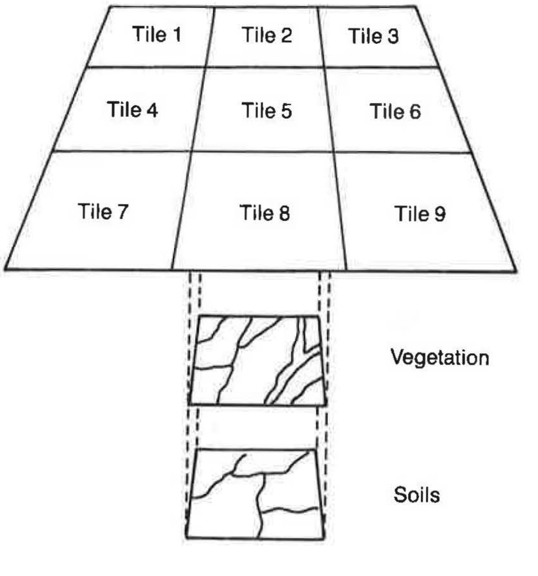
The second phase of the project (February 1989-April 1989) examined the potential role of satellite remote sensing data for the updating of GIS data layers. Experiments were carried out using data from the Landsat and SPOT satellites. It was possible to conclude that such data could be used to update the land cover and land use layers of the GIS periodically, offering the potential to monitor land use change over time and to map features of specific interest (e.g. vegetation types).

Both the Stann Creek (King *et al.*, 1989) and Belize Valley (Jenkin *et al.*, 1976) survey data have now been entered into the GIS; but extra resources will still be needed to enter elevation data (contours). The maps of this report will be entered into the GIS by the time the report is published.

APPENDIX 20: GIS OPERATIONS USING ARC/INFO

The ARC/INFO Geographical Information System is a commercially available software package developed by Environmental Systems Research Institute (ESRI) of Redlands, California. Like other GIS systems, it bases its operation on a view of the world as made up of a number of data layers or 'coverages', shown diagrammatically in Figure A20.1. Coverages available for any particular area might include soils, vegetation, geology, drainage, roads and land use. They are referenced by 'tic' marks which are points of known location on each data layer. In the current project, these tic marks are represented by the intersections of lines of 15 minutes of latitude and longitude, corresponding to the sheet boundaries of the 1:50,000 scale topographic series. The use of a grid allows integration of data drawn from existing maps and localized surveys. Tic marks need not be drawn from the boundaries of coverages. Commonly, tic marks can also be drawn from the ground control points used in aerial photography or satellite remote sensing geometric correction, allowing integration of data from these sources.

Figure A20.1



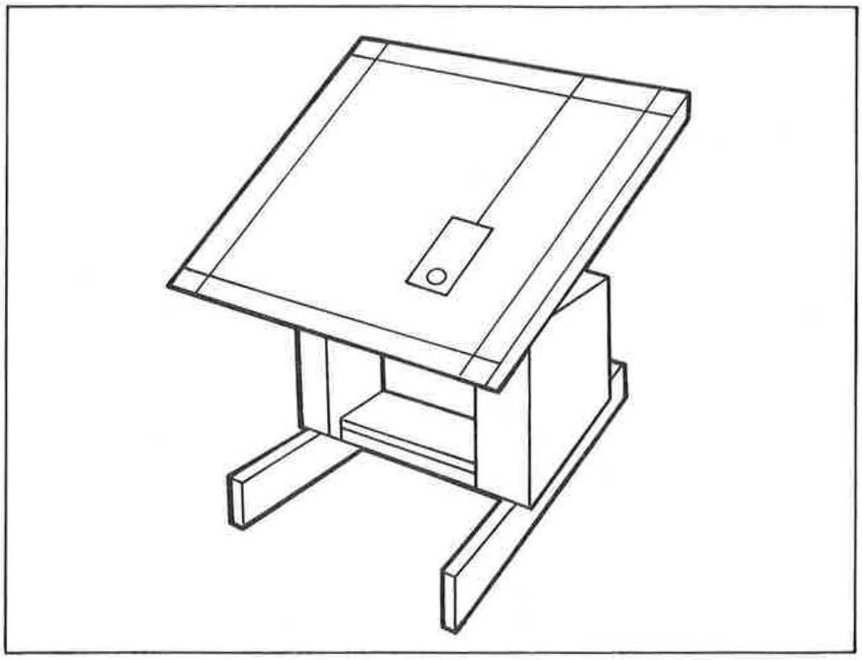
ARC/INFO consists of a graphics front end (ARC) linked to a relational database management system (INFO). The system consists of a number of program modules each designed to handle some aspect of data capture, data handling and output.

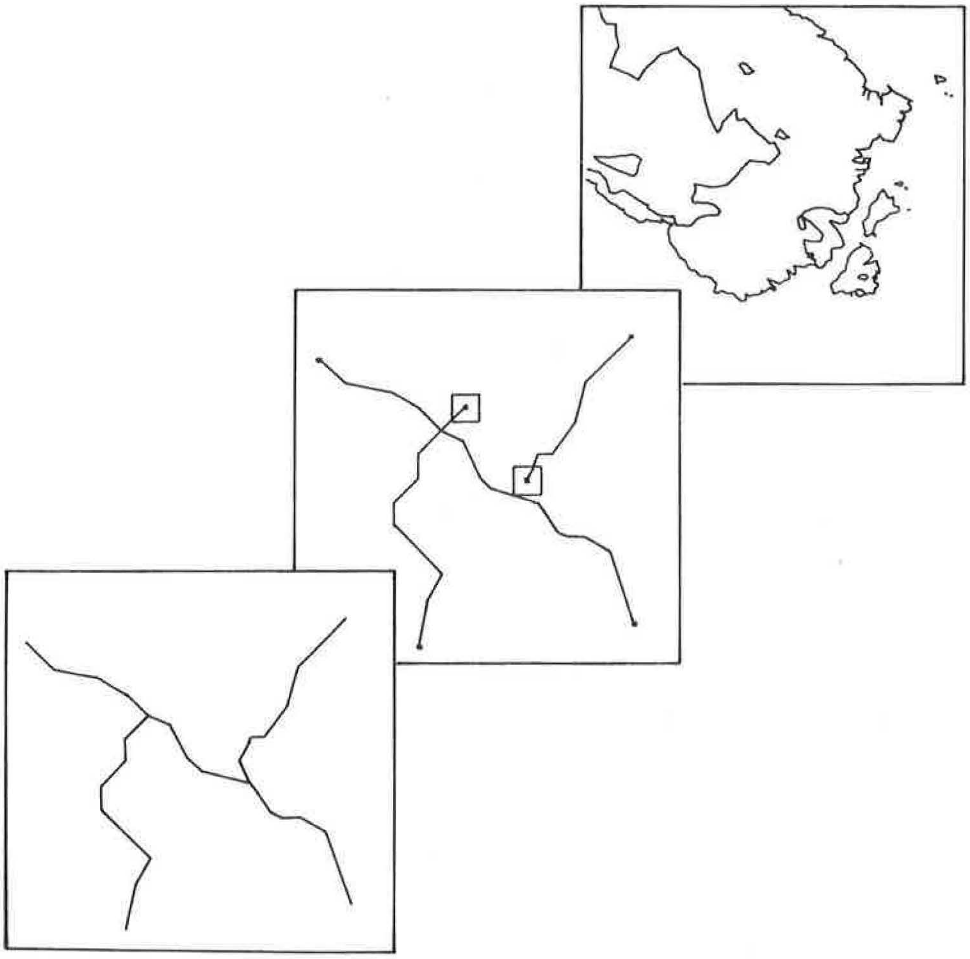
GIS operations revolve around the manipulation of geographical (locational) data and the attribute data associated with it. The geographical data is input in one of a number of ways. Most commonly it is digitised by way of a digitiser. (Figure A20.2 shows a manual cursor digitiser as used in this project.) The data is entered as line or segment data and then topologically 'cleaned' to produce either a line of polygon coverage. In this project the basic unit to which attributes refer is a land system polygon so the locational data has been cleaned to a polygon coverage.

Attribute data is held in code tables which can be relationally joined to the polygon attribute file. Once joined, the polygons can be shaded according to the attribute values held in the attribute look-up tables, making use of pre-defined shading patterns.

Figure A20.2

A manual cursor digitiser as used in the project





Relational operations

Once the data sets are available in ARC/INFO it is possible to perform relational overlay operations between coverage layers. This type of operation can be extremely complex, involving any number of coverage layers.

Output in ARC/INFO

The plotting module of ARC/INFO Version 4.0 (ARCPLOT) allows production of finished cartographic products. The module allows relational join operations during plotting and has facilities for the placement of text and positioning of features such as legends and scale bars, each of which are held as separate files.

Any number of relational operations can be carried out between coverages, and coverages containing detail such as roads or drainage can be called up during plotting. All these layers are referenced either by their respective tic marks, or by setting the map extent to be featured on the finished map sheet.

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