K : PROJECT EVALUATION

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K : PROJECT EVALUATION

K.1 Method and Basis of Evaluation

(1) General

The Master Plan for Integrated Rural Development in the San-Pédro Plain envisages, during its medium term, to construct the Grand Canal from San-Pédro dam to irrigate San-Pédro Paddy Development Area, then during the long-term period, to irrigate the Fahé and Cpt. Colonel development potential areas along the channel using the same water source. An appraisal is made using a lump sum data on investment of socio-economic infrastructure and rice production.

(2) Method of Evaluation

The appraisal compares 'with' situation and 'without' situation using the discounted flow of the net benefit of the both cases. In this appraisal only the increase of paddy production due to two crops a year, better water management, and better production method, which require a technical and social training, are enumerated. The plan envisages that it will choose a program with minimum investment from three options at the initial stage. At the same time it will observe the progress of technical and social transfer to the farmers, before full investment is done in order to make sure full use of water resource potentials.

(3) Basic Conditions

1) Foreign exchange rates

Project costs are estimated at the foreign exchange rate at; US$1.00 = ¥120.35, and FF. 1.00 = F.CFA 100.00 = ¥19.56 as of April 30, 1999. Therefore, F.CFA 1.00 is equivalent to ¥0.20.

2) Standard conversion factor and social discount rate

The standard conversion factor (SCF) at 0.87 was applied when the current financial costs to economic costs. And economic price of unskilled labour is estimated 50 % of financial one. The social discount rate in the Study made based on the present financial conditions in Côte d'Ivoire at 6.25 %.

3) Tangible and intangible benefits

Project benefits of the project was estimated on tangible benefits and intangible benefits were not considered for the economic and financial analysis. The project benefits estimated on the incremental paddy benefits and traffic benefits originated by Inspection road along the Grand Canal.

4) Farm Gate price of paddy

Based on the farm household economic survey, market survey, etc., the farm gate price of paddy is estimated at F.CFA 157/kg for financial price and F.CFA 147 /kg for economic price as shown Table K.1.1.

5) Production costs of paddy

As shown in Table K.1.2, the paddy production costs are estimated by proposed farming in agriculture. The economic costs were estimated condition mentioned above.

K.2 Evaluation of Master Plan

K.2.1 General

(1) Condition of Master Plan Evaluation

A preliminary appraisal is made using a lump sum data on investment of socio-economic infrastructure and rice production in the Interim Report. After the feasibility study on the high priority project area, they are reviewed based on the more detailed estimation. Then the results are described in this report

In this estimate, project life is set at 50 years and social discount rate at 6.25 %. At present the paddy cultivation is actually carried out only in about 50 ha, and the rest is mostly left as cultivable waste except the area used for tree crop cultivation. The net incremental benefit due to implementing the irrigation development of 965 ha is estimated on the assumption that the present areas of single paddy cultivation cover 100 ha, estimating the value of present tree crops is an equivalent amount of the produce from 50 ha single crop paddy cultivation.

(2) Synergetic Effects

Synergetic effects expected from the implementation of the master plan will culminate in the betterment of overall rural economy and life of the study area, which includes rural electrification. Intensification of agriculture usage in irrigated paddy production will attract more agricultural laborers into the study area. And in the level of national economy, rice produced from the irrigated paddy field, which will be rehabilitated and newly created by the plan, will contribute both to the goal of self-sufficiency of food crops and economy in terms of foreign reserve of the country.

K.2.2 Project Costs

(1) Project Cost

The Project costs of the integrated rural development in the Study Area are estimated that investment costs are represented by the costs for the total irrigated rice development covering 965 ha. Because other cost of development will be implemented by farmers' participation under the credits for farmers'.

As stated in Appendix J of this report, investment cost of total irrigation development in the Study Area by the construction of the Grand Canal from San-Pédro Dam, is estimated at F.CFA 8,806 million.

(2) Operation and Maintenance Costs

Operation and maintenance cost of irrigation and drainage system after completion of construction are estimated at F.CFA 65 million/year based on the previous experience and planed formulation of O&M. It includes the system operation and inspection costs including fuel or electricity for pumps/gates and salary for gate-men and pump operators, and the maintenance costs for irrigation facilities such as pumps and gates.

(3) Replacement Costs

Useful life of irrigation facilities such as pump, gates and other facilities is shorter than Project life. Therefore, the required replacement costs during the project life are estimated F.CFA 177 million as same as those of investment each facility.

(4) Sunk Cost of San-Pédro Dam

The water for irrigating 965 ha of paddy field in the Study Area taken from the San-Pédro Dam. Therefore, it is necessary to consider the investment cost of the dam. There was no available detailed cost for San-Pédro Dam. Then it is estimated at F.CFA 10 billion at the present cost by the Study Team. Irrigation water is estimated 5% of stored water in the dam and others are for hydro-electricity by CIE and water supply by SODECI. Also the project life of dam is estimated 100 years. Therefore, the annual depreciation of San-Pédro dam (financial cost) is estimated as follows:

F.CFA 10,000,000,000 X 5% X (1/100 year) = F.CFA 5,000,000/year

K.2.3 Incremental Benefits

The incremental cost benefits expected from the implementation of this project can be evaluated by comparing "the with and without project condition". With the implementation of the project, the following incremental benefits will be obtained.

1) Increased rice production with maximized utilization of San-Pédro dam water resources
2) Improved road network and increased length of inspection roads.

Estimated financial and economic production cost of rice double cropping is given in Table K.1.2. It compares both without project – direct sowing single cropping and with project – transplanting double cropping conditions. Without Project, financial production cost is estimated as F.CFA 228,292/ha, while the economic cost is estimated at F.CFA 134,168/ha. By the implementation of the project, with additional material, labor and water cost, the financial production cost is calculated to be F.CFA 418,790/ha and that of economic cost to be F.CFA 245,175/ha.

Table K.2.1 shows the benefits created by the construction of new roads. In total, 17.3 km of inspection roads (the length of Grand Canal is 18.2 km) and 4.9 km of O&M road as a connecting roads will be constructed through this project. The incremental transport benefit is estimated to be 40,625 persons/year.

K.2.4 Economic Evaluation

The methodology and details of the economic evaluation of the Master Plan Project for integrated rural development in San-Pédro Plain are presented in Tables K.2.2. With the above mentioned assumptions, the economic cost benefit ratio is estimated at: B/C = 5.0, the economic internal rate of return is estimated at: EIRR =13.0 %, and the economic net present value at a social discount rate of 6.25 % is estimated at NPV (6.25%)= F.CFA 6.52 billion.

K.2.5 Financial Evaluation

A farm gate price of paddy is set at F.CFA 157/kg in this financial evaluation. The cost benefit ratio is estimated at B/C= 3.8, the financial internal rate of return is estimated at FIRR= 9.7 %, and the financial net present value at a social discount rate of 6.25 % is estimated at NPV (6.25%)= F.CFA 3.78 billion. The calculation results are given in Table K.2.4.

Annual net income of the standard farmers with 1.5 ha land holding size, by paddy growing with two crops a year is estimated at about F.CFA 1,200,000, three times more than the present net income of F.CFA 400,000 by a single crop in a year.

K.2.6 Comparison Study for the San-Pédro Paddy Project Area

(1) Alternatives

Water source for the rehabilitation of San-Pédro paddy project (Cite Agricole), 575 ha with extension, was studied on the following three alternatives:

1) Alternative 1 : to rehabilitate existing pumps used and reinstalled during the former project and they will be operated by electricity.
2) Alternative 2 : to construct a headworks at Cpt. Colonel area and convey the taken water to the irrigation area by the gravity open canal.
3) Alternative 3 : to intake the San-Pédro dam by the un-used industrial water intake and convey the water to the irrigation area by the Grand Canal to be constructed newly.

(2) Economic Evaluation of Alternatives

In order to determine the best method of irrigation in the Project Area, economic evaluations were made. The condition of the investment cost and recurrent costs are as same as master plan evaluation, and the without-project condition was estimated 63 ha of single rice cultivation, but no sunk cost of San-Pédro dam and incremental benefits by inspection road were not considered.

Calculations of economic internal rate of return on each alternatives were estimated at 15.5 %, 10.0 %, 11.3 % for each alternatives as shown in Table K.2.5 to K.2.6.

K.3 Evaluation of San-Pédro Paddy Development Project

K.3.1 General

(1) Condition of Project Evaluation

The following assumptions are made for this project

1) Irrigated land created by the Project = 575 ha,
2) Construction period = 2 years,
3) Project life = 50 years,
4) Social discount rate = 6.25 %,
5) Financial prices are based on the market prices collected during this study period.

The conversion factors for the economic evaluation are considered as follows:

1) Standard Conversion Factor (SCF) = 0.87
2) Economic farm-gate paddy price = CFA franc 147
3) Economic unskilled labor factor = 0.5
4) Economic land price = 0
5) Sunk cost for San Pédro dam = F.CFA 3 million/ year
6) Sunk cost for ex-project = 0

(2) Synergetic Effects

Synergetic effects expected from the implementation of the master plan will culminate in the betterment of overall rural economy and life of the study area, which includes rural electrification. Intensification of agriculture usage in irrigated paddy production will attract more agricultural laborers into the study area. And in the level of national economy, rice produced from the irrigated paddy field, which will be rehabilitated and newly created by the plan, will contribute both to the goal of self-sufficiency of food crops and economy in terms of foreign reserve of the country.

The synergetic effects expected from the implementation of the San Pédro Paddy Irrigation Project will culminate in the betterment of overall rural economy and life of the Study Area and the region.

At the level of national economy

1) Increase of domestic paddy production will contribute for reducing the amount of import of rice, hence to the goal of both increase in the self-sufficiency rate of food crops and decrease in use of foreign exchange.

At the local level

2) The income from paddy production will have a stabilizing effect against vicissitudes of economy based on cacao and coffee production.

3) Intensification of agricultural usage in irrigated paddy production will eventually attract some more seasonal operators of cultivator and agricultural laborers to the area during the periods of plowing, transplanting and harvesting.

4) The paddy production using cultivators and a few thousand villagers with bicycles or motorcycles will attract a few small-scale rice-mills, mechanics and, probably and eventually, transporters to the area.

5) Creating a decent multiethnic farming society: Above mentioned features will help enable the villagers of Cité Agricole to lead a better rural life by their own initiative;

   a) Solid farm economy will secure the basic cash income far beyond subsistent farming for individual households.
   b) Harmonious life in the community with basic human needs will be maintained by continuous effort of running successfully the COOP of the Project, and keeping a friendly term with the neighboring communities by cooperating each other to look forward to gaining further betterment of the area by uniting.

Other tangible and non-tangible benefits expected from the implementation of this project can be summarized as follows.

1) Making use of potential water capacity of the San-Pédro dam
   Since the San-Pédro dam was built in the late 1970s, the stored water has been used only for non-regular power generation. The Project attempts to make use of the reservoir water for irrigation, for which around 5 % of the flow shall be allocated.

2) Reconstruction of an abandoned irrigated paddy field

This Project will be involved not only in restructuring the field and rehabilitating the village of Cité Agricole, which was founded by the selected settlers for cultivating the irrigated paddy field, but also in expanding both sizes. The net paddy field covered by the Project is to be 575 ha and number of households to engage in irrigated paddy farming is 384, which will support their family members of around 2,300 heads.

3) Technical transfer to immigrants

This Project will conduct training courses to the immigrants who are novices at paddy cultivation during two-year construction period so that it will go off without a hitch. Transmigration project from Java to the Barito basin of south Borneo by the Dutch government in 1938 has shown that even a single season trial would go a long way toward transferring the basic techniques of paddy cultivation.

4) Boosting paddy production

This Project will first produce more than 6 thousand tons of paddy in 2003 by farming with labor-intensive transplanting method twice a year. It would constitute about 12 % of the increased irrigated paddy production in that year planned by the PNR.

5) Capital formation utilizing unskilled labor quota required during the construction period

The immigrant and the residents of Cité Agricole, the future beneficiaries of the project will fill major part of the requirement of the unskilled labor during the construction period. They will save major part of their wages to appropriate the sum for their own capital requirement in the initial stage of the project.

6) Maintenance of an ecological equilibrium in the present environment

Paddy is the only crop suitable for a specific topographic land-type of 'bas-fonds', and with irrigated farming method, efficient and, at the same time, sustainable land use can be maintained.

7) Helping the improvement of the classified forest on the right bank of the San-Pédro river

The Project does this by;

a) giving up of installing a weir to avoid inundating the lower area of its right bank, and
b) receiving some immigrants from the illegal dwellers in the classified forest on the right bank to help the improvement of its quality as a specimen forest.

8) Opening of rural road using the right of way of the proposed Grand Canal

Creation of a grade-up rural road will enhance the over-all social amenity in the area along and beyond it by providing the inhabitants with a shorter through-road to and from San Pédro, quicker and safer, and passable all the year round.

K.3.2 Project Costs

Based on the above-mentioned prerequisite and methods, the San-Pédro Paddy Irrigation Project cost is estimated as shown below and detailed in Appendix J of this report:

(Unit: 1,000 F.CFA)

Item	Total
1. Irrigation and Drainage Facilities	4,817,371
2. Post-harvest Facilities	158,717
3 Land Development for Settlement Area	60,654
4. Rural Water Supply	25,175
5. Community Facilities	60,500
6. Consulting Service Cost	511,983
7. Project Administration and Supporting Services	516,363
Total	6,150,673
Physical contingencies	615,067
Grand Total	6,765,740

The annual costs for operation and maintenance of irrigation and drainage facilities of the Project is estimated as follows:

(Unit: 1,000 F.CFA/year)

Item 1.00%	Total
Maintenance Cost	35,408
Operation Expenses	35,092
Office Administration (Chief+4Admi.)	13,230
Gate Operator (5 operators)	9,072
Transportation (motor cycles & pick up)	5,250
Tools etc.(20%of labour costs)	5,310
Others Expenses (10% of Labour costs)	2,230
Total	70,501

Also the replacement costs of gates of intake, check gates and drainage sluices are to be renewed every 25 years and estimated as follows:

(Unit: 1,000 F.CFA/ 25years)

Item	Total
1. Drainage gates	140,000
2 Intake gates etc.	37,010
Total	177,010

Sunk cost of San-Pédro dam is estimated by the ratio of irrigation area of project (575 ha) against the total irrigation potential area (965 ha) of the Master Plan.

K.3.3 Incremental Benefits

Incremental benefits of the Project was estimated based on the following conditions:

	Without Project	With Project
Paddy cultivation Area (ha)	63	575
Unit yield per crop (ton/ha)	1.2	5.5
Paddy Cultivation a year	Single cropping	Double cropping
Annual Paddy production (ton)	75.6	6,325
Financial production cost (F.CAF/ha)	228,292	418,790
Economic production cost (F.CAF/ha)	133,527	243,532

The total project benefit by increase of paddy production is estimated at F.CFA 685 million/year for economic benefits and F.CFA 612 million/year including the incremental benefits of inspection road construction (F.CFA 41 million/year).

K.3.4 Economic Evaluation

(1) Economic Evaluation

Table K.3.1 shows the evaluation details and the alternatives considered in the San-Pédro Paddy Irrigation Project. Economic benefit/cost (E.B/C), economic net present value (ENPV) at the discount rate of 6.25 %, and economic internal rate of return (EIRR) are estimated at EB/C = 3.7, ENPV (at 6.25 %) = F.CFA 3,151 million, and EIRR = 10.4 %.

(2) Sensitivity Analysis

Three alternative cases with some probability of occurrence are examined for the San Pédro Paddy Irrigation Project as shown in Table K.3.2. The alternative cases for the priority project are; 1) increase of costs by 10 %, 2) decrease of benefits by 10 %, and 3) combination of the case 1) and 2). The results are 9.3 %, 9.2 % and 8.3 %, respectively.

K.3.5 Financial Evaluation

(1) Financial Evaluation

Financial benefit/cost (F.B/C), financial net present value (FNPV) at the discount rate of 6.25 %, and financial internal rate of return (FIRR) are estimated at FB/C = 2.8, FNPV (at 6.25 %) = F.CFA 1,040 million, and FIRR = 7.4 %. Table K.3.3 illustrates the details of financial evaluation

(2) Sensitivity Analysis

Three alternative cases with some probability of occurrence are examined for the San Pédro Paddy Irrigation Project as shown in Table K.3.2. Those alternative cases are; 1) increase of costs by 10 per cent, 2) decrease of benefits by 10 per cent, and 3) combination of the case 1) and 2). The results are 6.6 %, 6.5 % and 5.7 %, respectively.

(3) Farm Income of Standard Farm Household

Table K.3.4 gives the farm economy of an average satellite household of the Project. Farmer holds 3.6 ha of plain lowland on average at present. The average cropped area of rice in the last 5 years is only 1.0 ha per farmer to the rain-fed field condition. The production is estimated at 1,171 kg/ha on average. The net income is estimated at minus F.CAF 39,524/farmer as shown in table below.

In the plan, rice is cultivated twice a year. The paddy production is estimated at 15,000 kg/year per farmer, which is equivalent to 13 times that of the present. The net income is estimated at F.CAF 1,160,940/farmer, which is nearly equivalent to the average annual salary in Côte d'Ivoire.

In the case of introduction of tomato in the Area of 0.1 ha of the 1st cropping, the total net income per farmer is estimated to be F.CAF 2,426,162/year, which is twice the average annual salary in Côte d'Ivoire. In the case of introduction of lettuce, the net income per framer is estimated to be F.CFA 1,263,852/year as shown below.

Conditions	Land Holding size (ha)	Cultivated Crops	Cultivated Area (ha)	Yield (kg/ha)	Production (kg)	Net Income (F.CAF)
Present	3.6	Rice	1.0	1,171	1,171	-39,524
[Plan 1] Rice + Rice	1.5	Rice(1st)	1.5	5,000	7,500	580,470
		Rice(2nd)	1.5	5,000	7,500	580,470
		Total	3.0	-	15,000	1,160,940
[Plan 2] Rice+Tomato	1.5	Rice(1st)	1.4	5,000	7,000	541,772
		Rice(2nd)	1.5	5,000	7,500	580,470
		Tomato(1st)	0.1	20,000	2,000	1,303,920
		Total	3.0	-	16,500	2,426,162
[Plan 3] Rice+Lettuce	1.5	Rice(1st)	1.4	5,000	7,000	541,772
		Rice(2nd)	1.5	5,000	7,500	580,470
		Lettuce(1st)	0.1	20,000	2,000	141,610
		Total	3.0	-	16,500	1,263,852

With the introduction of transplanting method in rice crop, in which an average yield of 5.5 ton/ha/crop is envisaged, the household economy of the Project Area will eventually be improved. With the land holding of 1.5 ha and two crops a year, an average net farm income of the majority households will reach F.CFA 1.6 million of 1998 price by selling paddy to their cooperative at the price of F.CFA 157 /kg minus 1 % commission after deducting 1.2 ton of paddy for its self-consumption.

After paying the annual debt of housing loan F.CFA 234,000, and deducting 10% saving, disposable income would be F.CFA 1.4 million. Assuming that most of the basic foodstuff be self-sufficient, the disposable income would be 28 % more than that of the average residents of San-Pédro city.

Table K.1.1 Calculation of Economic Price of Rice

			Financial Price	SCF 0.87	Coefficient Eco/Fin	Economic Price
FOB Bangkok*1	US$/MT		270		1.00	270
IF*2	US$/MT		42.7		1.00	42.7
CIF San Pedro	US$/MT		313		1.00	313
	US$/kg		0.313		1.00	0.313
*3	CFA/$		594.8		1.00	594.8
			186		1.00	186
Import duties*4			33.7	18.1%	0.0	0
Stevedore			10.2	5.5%	0.50	5.1
Package + Warehouse			10.2	5.5%	0.87	8.9
Interest + Insurance			7.4	4.0%	1.00	7.4
Port Margin			37.2	20.0%	0.87	32.4
Port gate*5			285	53.1%		240
Transport	*	0.10	2.5	25.0	0.87	2.2 */kg/km
Margin: wholesale + retail			25.6	9.0%	1.00	25.6
Rice: retail price			313			268
Mill Charge			20.0	65%*6	0.87	17.4 65%*6
Paddy at mill gate			183			157
Transport	*	0.10	-0.5	5.0	0.87	-0.4 */kg/km
Commission			-8.7	5%	1.00	-8.7
Paddy at farm gate			**174**			**147**

Note:
*1: White 25% super; Bht35.6/$ as of 5th Nov.
*2: Freight US$40/MT; Insurance 1%
*3: Exchange Rates US$1.00=¥120.15=594.8F.CFA, 1.00F.CFA=¥0.202 (as March 1, 1999)
*4: 18.1% of duty rate is applicable to rice whose rate of broken rice is more than 16 %.
*5: Government Indicative Price: 283.4 CFA franc as of Sep.'98.
*6: conversion factor from paddy to milled rice

Table K.1.2 Financial and Economic production Cost of Paddy

(1) Without project - direct sowing single cropping (Unit:F.CFA/ha)

	Item	Details	Financial Cost		Economic Cost	
			Materials*	Labor	Materials*	Labor
Material Cost	Seed cost		17,308		15,058	
	Fertilizer cost		9,244		8,012	
	Herbicide cost		10,174		8,851	
	Pesticide		256		223	
	Insecticide		2,538		2,208	
	Machinery		14,593		12,696	
Labour Costs	Nursery preparation			0		0
	Land preparation			12,760		6,380
	Sowing			10,780		5,390
	Transplanting			0		0
	Weeding			11,110		5,555
	Disease, pest control			2,340		1,170
	Fertilizer application			2,860		1,430
	Bird control			113,100		56,550
	Harvesting			21,230		10,615
Total			54,113	174,180	47,078	87,090
Production Cost			228,293		134,168	

(2) With Project : Transplanting Cultivation (Unit:F.CFA/ha)

	Item	Details	Financial Cost		Economic Cost	
			Materials*	Labor	Materials*	Labor
Material Cost	Seed cost	35 kg/ha x 300 F/kg	10,500		9,135	
	Fertilizer cost					
	For nursery	NPK: 8kg(10-20-20) x 190 F/kg	1,520		1,322	
		Urea: 5 kg(N46) x 170 F/kg	850		740	
	For main field	NPK: 200 kg(10-20-20) x 190 F/kg	38,000		33,060	
		Urea: 100 kg(N46) x 170 F/kg	17,000		14,790	
	Herbicide cost	Ronstar 7,000 F/L x 4 L	28,000		24,360	
	Insecticide cost**(If necessary)	Furadan 5G: 1,800 F/kg x 28 kg/ha	(50,400)			
	Power tiller cost					
	For nursery	2 round, including operator charge	3,300		2,871	
	For main field	"	65,100		56,637	
Labor Cost	1st plowing	1.5men x 1,100 F/day		1,650		825
	Nursery preparation	2men x 1,100 F/day		2,200		1,100
	Sowing	1 man x 1,100 F/day		1,100		550
	Top-dressing to nursery	0.7 man x 1,100 F/day		770		385
	Basal fertilizer to main field	2men x 1,100 F/day		2,200		1,100
	2nd plowing	1.5man x 1,100 F/day		1,650		825
	Transplanting	40 men x 1,500 F/day		60,000		30,000
	Application of herbicide	2men x 1,100 F/day		2,200		1,100
	1st top-dressing to main field	2men x 1,100 F/day		2,200		1,100
	Manual weeding	10men x 1,100 F/day		11,000		5,500
	Insecticide application	4men x 1,800 F/day		7,200		3,600
	2nd top-dressing to main field	1man x 1,100 F/day		1,100		550
	Bird control	3men x 25days x 750 F/day		56,250		28,125
	Harvesting	40 men x 1,100 F/day		44,000		22,000
	Threshing	10 men x 1,100 F/day		11,000		5,500
	Water charge	50,000 F/ha/season		50,000		0
Total			164,270	254,520	142,915	102,260
Production cost			418,790		245,175	

Notes: * material costs : KR-II price in 1998
** insecticide cost is not included

Source: JICA Study Team

Table K.2.1 Incremental Benefit of Transportation by the Inspection Road

Inspect.Road	17.9km
Connectt.Road	4.9km
Total Length	22.8km

Fah/SanP	old	44.6km	
Fah/SanP	new	26.4km	59%
Dist. shortened		18.2km	41%

Tab/Sp	present	43.3km
Tab/Sp	new	44.7km

Villages	Population	Adult Pop.	Cost of Transportation				
			From /To	w/o project	with project	Incremental Benefit	
8 Main villages	728		Fahé - San-Pédro	1,000	600	400	Minibus
others	728		G.Gabo - San-Pédr	165	0	165	= FCFA1100/8*1.2hr.
Subtotal	1,456						5 km walking cost
Scaf	2,667						
Fahe	1,036		Travel Person	Time/Y	R/T	Incremental Benefit/Y	
Subtotal	5,159	1,720	860	50	800	34,393	Unit: 1,000CFA
Colonel	396		(50%)				
G.Gabo	240						
CA	497						
Subtotal	1,133	378	189	100	330	6,232	
Total	7,748	2,097	Total incremental Benefits			40,625	Unit: 1,000CFA

Table K.2.2 Economic Evalaution of Master Plan

	Year	Area (ha)		Economic	Economic	Economic	Sunk	E
		with	out	Benefit	Cost	O&M cos	Cost	B-C
1	2001	0	121	0	2,210,421	0	0	-2,210,421
2	2002	0	121	0	2,947,229	0	0	-2,947,229
3	2003	575	121	676,099	0	33,090	5,000	638,009
4	2004	575	121	676,099	0	33,090	5,000	638,009
5	2005	575	121	676,099	0	33,090	5,000	638,009
6	2006	575	121	676,099	1,473,614	33,090	5,000	-835,605
7	2007	773	121	900,061	736,807	44,484	5,000	113,770
8	2008	965	121	1,117,237	0	55,533	5,000	1,056,703
9	2009	965	121	1,117,237	0	55,533	5,000	1,056,703
10	2010	965	121	1,117,237	0	55,533	5,000	1,056,703
11	2011	965	121	1,117,237	0	55,533	5,000	1,056,703
12	2012	965	121	1,117,237	0	55,533	5,000	1,056,703
13	2013	965	121	1,117,237	0	55,533	5,000	1,056,703
14	2014	965	121	1,117,237	0	55,533	5,000	1,056,703
15	2015	965	121	1,117,237	0	55,533	5,000	1,056,703
16	2016	965	121	1,117,237	0	55,533	5,000	1,056,703
17	2017	965	121	1,117,237	0	55,533	5,000	1,056,703
18	2018	965	121	1,117,237	0	55,533	5,000	1,056,703
19	2019	965	121	1,117,237	0	55,533	5,000	1,056,703
20	2020	965	121	1,117,237	0	55,533	5,000	1,056,703
21	2021	965	121	1,117,237	0	55,533	5,000	1,056,703
22	2022	965	121	1,117,237	0	55,533	5,000	1,056,703
23	2023	965	121	1,117,237	0	55,533	5,000	1,056,703
24	2024	965	121	1,117,237	0	55,533	5,000	1,056,703
25	2025	965	121	1,117,237	0	55,533	5,000	1,056,703
26	2026	965	121	1,117,237	151,909	55,533	5,000	904,794
27	2027	965	121	1,117,237	0	55,533	5,000	1,056,703
28	2028	965	121	1,117,237	0	55,533	5,000	1,056,703
29	2029	965	121	1,117,237	0	55,533	5,000	1,056,703
30	2030	965	121	1,117,237	0	55,533	5,000	1,056,703
31	2031	965	121	1,117,237	0	55,533	5,000	1,056,703
32	2032	965	121	1,117,237	0	55,533	5,000	1,056,703
33	2033	965	121	1,117,237	0	55,533	5,000	1,056,703
34	2034	965	121	1,117,237	0	55,533	5,000	1,056,703
35	2035	965	121	1,117,237	0	55,533	5,000	1,056,703
36	2036	965	121	1,117,237	0	55,533	5,000	1,056,703
37	2037	965	121	1,117,237	0	55,533	5,000	1,056,703
38	2038	965	121	1,117,237	0	55,533	5,000	1,056,703
39	2039	965	121	1,117,237	0	55,533	5,000	1,056,703
40	2040	965	121	1,117,237	0	55,533	5,000	1,056,703
41	2041	965	121	1,117,237	0	55,533	5,000	1,056,703
42	2042	965	121	1,117,237	0	55,533	5,000	1,056,703
43	2043	965	121	1,117,237	0	55,533	5,000	1,056,703
44	2044	965	121	1,117,237	0	55,533	5,000	1,056,703
45	2045	965	121	1,117,237	0	55,533	5,000	1,056,703
46	2046	965	121	1,117,237	0	55,533	5,000	1,056,703
47	2047	965	121	1,117,237	0	55,533	5,000	1,056,703
48	2048	965	121	1,117,237	0	55,533	5,000	1,056,703
49	2049	965	121	1,117,237	0	55,533	5,000	1,056,703
50	2050	965	121	1,117,237	0	55,533	5,000	1,056,703

EB/C=	5.0
ENPV=	6,519,346
EIRR=	13.0%

Table K.2.3 Sensitivity Analysis of the Master Plan Evaluation

				Financial					Economic				
	Year	Area (ha)		Benefit -10%		Cost +10%		B-10%C+10%	Benefit -10%		Cost +10%		B-10%C+10%
		with	out	B-10%	B(-10%)-C	C+10%	B-C(+10%	B-10%C+10%	B-10%	B(-10%)-C	C+10%	B-C(+10%)	B-10%C+10%
1	2001	0	121	0	-2,611,688	2,905,857	-2,905,857	-2,905,857	0	-2,210,421	2,431,464	-2,431,464	-2,431,464
2	2002	0	121	0	-3,522,251	3,874,476	-3,874,476	-3,874,476	0	-2,917,229	3,241,951	-3,241,951	-3,241,951
3	2003	575	121	546,273	507,417	42,741	564,229	503,532	608,489	570,399	41,899	634,200	566,590
4	2004	575	121	546,273	507,417	42,741	564,229	503,532	608,489	570,399	41,899	634,200	566,590
5	2005	575	121	546,273	507,417	42,741	564,229	503,532	608,489	570,399	41,899	634,200	566,590
6	2006	575	121	546,273	-1,253,708	1,979,979	-1,373,009	-1,433,706	608,489	-903,215	1,662,875	-986,776	-1,054,386
7	2007	773	121	722,588	-210,211	1,026,078	-223,203	-303,490	810,055	23,763	864,921	35,140	-54,866
8	2008	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
9	2009	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
10	2010	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
11	2011	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
12	2012	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
13	2013	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
14	2014	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
15	2015	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
16	2016	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
17	2017	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
18	2018	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
19	2019	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
20	2020	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
21	2021	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
22	2022	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
23	2023	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
24	2024	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
25	2025	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
26	2026	965	121	893,560	654,538	262,924	729,920	630,636	1,005,513	793,071	233,686	883,550	771,826
27	2027	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
28	2028	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
29	2029	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
30	2030	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
31	2031	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
32	2032	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
33	2033	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
34	2034	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
35	2035	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
36	2036	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
37	2037	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
38	2038	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
39	2039	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
40	2040	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
41	2041	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
42	2042	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
43	2043	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
44	2044	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
45	2045	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
46	2046	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
47	2047	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
48	2048	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
49	2049	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926
50	2050	965	121	893,560	828,350	71,731	921,113	821,829	1,005,513	944,979	66,587	1,050,650	938,926

Financial	Base	10%	Cost
Base	9.7%	8.7%	
-10%	8.6%	7.7%	
Benefit			

Economic	Base	10%	Cost
Base	13.0%	11.8%	
-10%	11.7%	10.6%	
Benefit			

Table K.2.4 Financial Evaluation of Master Plan

	Year	Area (ha)		Financial	Investment	Investment: Local Currenc		Taxes	O&M	Cost	Financial
		with	out	Benefit	F/C	Major P.	Unskilled L.			Total	Cashflow
1	2001	0	121	0	1,525,536	719,847	117,236	279,068	0	2,641,688	-2,641,688
2	2002	0	121	0	2,034,048	959,796	156,315	372,091	0	3,522,251	-3,522,251
3	2003	575	121	606,970	0	0	0	4,216	34,640	38,856	568,114
4	2004	575	121	606,970	0	0	0	4,216	34,640	38,856	568,114
5	2005	575	121	606,970	0	0	0	4,216	34,640	38,856	568,114
6	2006	575	121	606,970	1,017,024	479,898	78,158	190,261	34,640	1,799,981	-1,193,011
7	2007	773	121	802,875	508,512	239,949	39,079	98,690	46,568	932,798	-129,923
8	2008	965	121	992,844				7,075	58,135	65,210	927,634
9	2009	965	121	992,844				7,075	58,135	65,210	927,634
10	2010	965	121	992,844				7,075	58,135	65,210	927,634
11	2011	965	121	992,844				7,075	58,135	65,210	927,634
12	2012	965	121	992,844				7,075	58,135	65,210	927,634
13	2013	965	121	992,844				7,075	58,135	65,210	927,634
14	2014	965	121	992,844				7,075	58,135	65,210	927,634
15	2015	965	121	992,844				7,075	58,135	65,210	927,634
16	2016	965	121	992,844				7,075	58,135	65,210	927,634
17	2017	965	121	992,844				7,075	58,135	65,210	927,634
18	2018	965	121	992,844				7,075	58,135	65,210	927,634
19	2019	965	121	992,844				7,075	58,135	65,210	927,634
20	2020	965	121	992,844				7,075	58,135	65,210	927,634
21	2021	965	121	992,844				7,075	58,135	65,210	927,634
22	2022	965	121	992,844				7,075	58,135	65,210	927,634
23	2023	965	121	992,844				7,075	58,135	65,210	927,634
24	2024	965	121	992,844				7,075	58,135	65,210	927,634
25	2025	965	121	992,844				7,075	58,135	65,210	927,634
26	2026	965	121	992,844	128,210	27,240		25,436	58,135	239,021	753,822
27	2027	965	121	992,844				7,075	58,135	65,210	927,634
28	2028	965	121	992,844				7,075	58,135	65,210	927,634
29	2029	965	121	992,844				7,075	58,135	65,210	927,634
30	2030	965	121	992,844				7,075	58,135	65,210	927,634
31	2031	965	121	992,844				7,075	58,135	65,210	927,634
32	2032	965	121	992,844				7,075	58,135	65,210	927,634
33	2033	965	121	992,844				7,075	58,135	65,210	927,634
34	2034	965	121	992,844				7,075	58,135	65,210	927,634
35	2035	965	121	992,844				7,075	58,135	65,210	927,634
36	2036	965	121	992,844				7,075	58,135	65,210	927,634
37	2037	965	121	992,844				7,075	58,135	65,210	927,634
38	2038	965	121	992,844				7,075	58,135	65,210	927,634
39	2039	965	121	992,844				7,075	58,135	65,210	927,634
40	2040	965	121	992,844				7,075	58,135	65,210	927,634
41	2041	965	121	992,844				7,075	58,135	65,210	927,634
42	2042	965	121	992,844				7,075	58,135	65,210	927,634
43	2043	965	121	992,844				7,075	58,135	65,210	927,634
44	2044	965	121	992,844				7,075	58,135	65,210	927,634
45	2045	965	121	992,844				7,075	58,135	65,210	927,634
46	2046	965	121	992,844				7,075	58,135	65,210	927,634
47	2047	965	121	992,844				7,075	58,135	65,210	927,634
48	2048	965	121	992,844				7,075	58,135	65,210	927,634
49	2049	965	121	992,844				7,075	58,135	65,210	927,634
50	2050	965	121	992,844				7,075	58,135	65,210	927,634

FB/C=	3.8
FNPV=	3,775,687
FIRR=	9.7%

Table K.2.5 Economic Evaluation of Alternative 1 : Pump rehabilitation

		Area (ha)		Economic	Economic	Economic	Sunk	E
		with	w/o	Benefit	Cost	O&M	Cost	B-C
1	2001	0	63	0	1,473,803	0	0	-1,473,803
2	2002	0	63	0	1,473,803	0	0	-1,473,803
3	2003	510	63	574,450	0	74,517	0	499,933
4	2004	510	63	574,450	0	74,517	0	499,933
5	2005	510	63	574,450	0	74,517	0	499,933
6	2006	510	63	574,450	0	74,517	0	499,933
7	2007	510	63	574,450	0	74,517	0	499,933
8	2008	510	63	574,450	0	74,517	0	499,933
9	2009	510	63	574,450	0	74,517	0	499,933
10	2010	510	63	574,450	0	74,517	0	499,933
11	2011	510	63	574,450	0	74,517	0	499,933
12	2012	510	63	574,450	0	74,517	0	499,933
13	2013	510	63	574,450	0	74,517	0	499,933
14	2014	510	63	574,450	0	74,517	0	499,933
15	2015	510	63	574,450	0	74,517	0	499,933
16	2016	510	63	574,450	0	74,517	0	499,933
17	2017	510	63	574,450	382,788	74,517	0	117,145
18	2018	510	63	574,450	0	74,517	0	499,933
19	2019	510	63	574,450	0	74,517	0	499,933
20	2020	510	63	574,450	0	74,517	0	499,933
21	2021	510	63	574,450	0	74,517	0	499,933
22	2022	510	63	574,450	0	74,517	0	499,933
23	2023	510	63	574,450	0	74,517	0	499,933
24	2024	510	63	574,450	0	74,517	0	499,933
25	2025	510	63	574,450	0	74,517	0	499,933
26	2026	510	63	574,450		74,517	0	499,933
27	2027	510	63	574,450	0	74,517	0	499,933
28	2028	510	63	574,450	0	74,517	0	499,933
29	2029	510	63	574,450	0	74,517	0	499,933
30	2030	510	63	574,450	0	74,517	0	499,933
31	2031	510	63	574,450	0	74,517	0	499,933
32	2032	510	63	574,450	0	74,517	0	499,933
33	2033	510	63	574,450	0	74,517	0	499,933
34	2034	510	63	574,450	0	74,517	0	499,933
35	2035	510	63	574,450	0	74,517	0	499,933
36	2036	510	63	574,450	0	74,517	0	499,933
37	2037	510	63	574,450	382,788	74,517	0	117,145
38	2038	510	63	574,450	0	74,517	0	499,933
39	2039	510	63	574,450	0	74,517	0	499,933
40	2040	510	63	574,450	0	74,517	0	499,933
41	2041	510	63	574,450	0	74,517	0	499,933
42	2042	510	63	574,450	0	74,517	0	499,933
43	2043	510	63	574,450	0	74,517	0	499,933
44	2044	510	63	574,450	0	74,517	0	499,933
45	2045	510	63	574,450	0	74,517	0	499,933
46	2046	510	63	574,450	0	74,517	0	499,933
47	2047	510	63	574,450	0	74,517	0	499,933
48	2048	510	63	574,450	0	74,517	0	499,933
49	2049	510	63	574,450	0	74,517	0	499,933
50	2050	510	63	574,450	0	74,517	0	499,933

EB/C=	3.8
ENPV=	3,829,739
EIRR=	15.5%

Table K.2.6 Economic Evalauation of Alternative 2 : Headworks at Cpt.

	Year	Area (ha)		Economic	Economic	Economic	Sunk	Economic
		with	out	Benefit	Cost	O&M	Cost	Cashflow
1	2001	0	63	0	2,814,447	0	0	-2,814,447
2	2002	0	63	0	2,814,447	0	0	-2,814,447
3	2003	575	63	647,973	0	50,306	0	597,667
4	2004	575	63	647,973	0	50,306	0	597,667
5	2005	575	63	647,973	0	50,306	0	597,667
6	2006	575	63	647,973	0	50,306	0	597,667
7	2007	575	63	647,973	0	50,306	0	597,667
8	2008	575	63	647,973	0	50,306	0	597,667
9	2009	575	63	647,973	0	50,306	0	597,667
10	2010	575	63	647,973	0	50,306	0	597,667
11	2011	575	63	647,973	0	50,306	0	597,667
12	2012	575	63	647,973	0	50,306	0	597,667
13	2013	575	63	647,973	0	50,306	0	597,667
14	2014	575	63	647,973	0	50,306	0	597,667
15	2015	575	63	647,973	0	50,306	0	597,667
16	2016	575	63	647,973	0	50,306	0	597,667
17	2017	575	63	647,973	0	50,306	0	597,667
18	2018	575	63	647,973	0	50,306	0	597,667
19	2019	575	63	647,973	0	50,306	0	597,667
20	2020	575	63	647,973	0	50,306	0	597,667
21	2021	575	63	647,973	0	50,306	0	597,667
22	2022	575	63	647,973	0	50,306	0	597,667
23	2023	575	63	647,973	0	50,306	0	597,667
24	2024	575	63	647,973	0	50,306	0	597,667
25	2025	575	63	647,973	0	50,306	0	597,667
26	2026	575	63	647,973	133,888	50,306	0	463,779
27	2027	575	63	647,973	0	50,306	0	597,667
28	2028	575	63	647,973	0	50,306	0	597,667
29	2029	575	63	647,973	0	50,306	0	597,667
30	2030	575	63	647,973	0	50,306	0	597,667
31	2031	575	63	647,973	0	50,306	0	597,667
32	2032	575	63	647,973	0	50,306	0	597,667
33	2033	575	63	647,973	0	50,306	0	597,667
34	2034	575	63	647,973	0	50,306	0	597,667
35	2035	575	63	647,973	0	50,306	0	597,667
36	2036	575	63	647,973	0	50,306	0	597,667
37	2037	575	63	647,973	0	50,306	0	597,667
38	2038	575	63	647,973	0	50,306	0	597,667
39	2039	575	63	647,973	0	50,306	0	597,667
40	2040	575	63	647,973	0	50,306	0	597,667
41	2041	575	63	647,973	0	50,306	0	597,667
42	2042	575	63	647,973	0	50,306	0	597,667
43	2043	575	63	647,973	0	50,306	0	597,667
44	2044	575	63	647,973	0	50,306	0	597,667
45	2045	575	63	647,973	0	50,306	0	597,667
46	2046	575	63	647,973	0	50,306	0	597,667
47	2047	575	63	647,973	0	50,306	0	597,667
48	2048	575	63	647,973	0	50,306	0	597,667
49	2049	575	63	647,973	0	50,306	0	597,667
50	2050	575	63	647,973	0	50,306	0	597,667

EB/C=	3.8
ENPV=	2,839,635
EIRR=	10.0%

Table K.2.7 Econmic Evalaution of Alternative 3: the Grand Canal

		Area (ha)		Economic	Economic	Economic	Sunk	Economic
		with	out	Benefit	Cost	O&M	Cost	Cashflow
1	2001	0	63	0	2,643,078	0	0	-2,643,078
2	2002	0	63	0	2,643,078	0	0	-2,643,078
3	2003	575	63	683,317	0	45,002	3,026	635,289
4	2004	575	63	683,317	0	45,002	3,026	635,289
5	2005	575	63	683,317	0	45,002	3,026	635,289
6	2006	575	63	683,317	0	45,002	3,026	635,289
7	2007	575	63	683,317	0	45,002	3,026	635,289
8	2008	575	63	683,317	0	45,002	3,026	635,289
9	2009	575	63	683,317	0	45,002	3,026	635,289
10	2010	575	63	683,317	0	45,002	3,026	635,289
11	2011	575	63	683,317	0	45,002	3,026	635,289
12	2012	575	63	683,317	0	45,002	3,026	635,289
13	2013	575	63	683,317	0	45,002	3,026	635,289
14	2014	575	63	683,317	0	45,002	3,026	635,289
15	2015	575	63	683,317	0	45,002	3,026	635,289
16	2016	575	63	683,317	0	45,002	3,026	635,289
17	2017	575	63	683,317	0	45,002	3,026	635,289
18	2018	575	63	683,317	0	45,002	3,026	635,289
19	2019	575	63	683,317	0	45,002	3,026	635,289
20	2020	575	63	683,317	0	45,002	3,026	635,289
21	2021	575	63	683,317	0	45,002	3,026	635,289
22	2022	575	63	683,317	0	45,002	3,026	635,289
23	2023	575	63	683,317	0	45,002	3,026	635,289
24	2024	575	63	683,317	0	45,002	3,026	635,289
25	2025	575	63	683,317	0	45,002	3,026	635,289
26	2026	575	63	683,317	151,909	45,002	3,026	483,380
27	2027	575	63	683,317	0	45,002	3,026	635,289
28	2028	575	63	683,317	0	45,002	3,026	635,289
29	2029	575	63	683,317	0	45,002	3,026	635,289
30	2030	575	63	683,317	0	45,002	3,026	635,289
31	2031	575	63	683,317	0	45,002	3,026	635,289
32	2032	575	63	683,317	0	45,002	3,026	635,289
33	2033	575	63	683,317	0	45,002	3,026	635,289
34	2034	575	63	683,317	0	45,002	3,026	635,289
35	2035	575	63	683,317	0	45,002	3,026	635,289
36	2036	575	63	683,317	0	45,002	3,026	635,289
37	2037	575	63	683,317	0	45,002	3,026	635,289
38	2038	575	63	683,317	0	45,002	3,026	635,289
39	2039	575	63	683,317	0	45,002	3,026	635,289
40	2040	575	63	683,317	0	45,002	3,026	635,289
41	2041	575	63	683,317	0	45,002	3,026	635,289
42	2042	575	63	683,317	0	45,002	3,026	635,289
43	2043	575	63	683,317	0	45,002	3,026	635,289
44	2044	575	63	683,317	0	45,002	3,026	635,289
45	2045	575	63	683,317	0	45,002	3,026	635,289
46	2046	575	63	683,317	0	45,002	3,026	635,289
47	2047	575	63	683,317	0	45,002	3,026	635,289
48	2048	575	63	683,317	0	45,002	3,026	635,289
49	2049	575	63	683,317	0	45,002	3,026	635,289
50	2050	575	63	683,317	0	45,002	3,026	635,289

EB/C=	4.2
ENPV=	3,653,164
EIRR=	11.3%

Table K.3.1 Economic Evaluation of the Project

Year		Area (ha) with	Area (ha) out	Economic Benefit	Economic Investment Cost	Economic O&M	Sunk Cost	Economic Cash Flow
1	2001	0	63	0	2,811,664	0	0	-2,811,664
2	2002	0	63	0	2,811,664	0	0	-2,811,664
3	2003	575	63	683,048	0	59,222	3,026	620,799
4	2004	575	63	683,048	0	59,222	3,026	620,799
5	2005	575	63	683,048	0	59,222	3,026	620,799
6	2006	575	63	683,048	0	59,222	3,026	620,799
7	2007	575	63	683,048	0	59,222	3,026	620,799
8	2008	575	63	683,048	0	59,222	3,026	620,799
9	2009	575	63	683,048	0	59,222	3,026	620,799
10	2010	575	63	683,048	0	59,222	3,026	620,799
11	2011	575	63	683,048	0	59,222	3,026	620,799
12	2012	575	63	683,048	0	59,222	3,026	620,799
13	2013	575	63	683,048	0	59,222	3,026	620,799
14	2014	575	63	683,048	0	59,222	3,026	620,799
15	2015	575	63	683,048	0	59,222	3,026	620,799
16	2016	575	63	683,048	0	59,222	3,026	620,799
17	2017	575	63	683,048	0	59,222	3,026	620,799
18	2018	575	63	683,048	0	59,222	3,026	620,799
19	2019	575	63	683,048	0	59,222	3,026	620,799
20	2020	575	63	683,048	0	59,222	3,026	620,799
21	2021	575	63	683,048	0	59,222	3,026	620,799
22	2022	575	63	683,048	0	59,222	3,026	620,799
23	2023	575	63	683,048	0	59,222	3,026	620,799
24	2024	575	63	683,048	0	59,222	3,026	620,799
25	2025	575	63	683,048	0	59,222	3,026	620,799
26	2026	575	63	683,048	151,909	59,222	3,026	468,890
27	2027	575	63	683,048	0	59,222	3,026	620,799
28	2028	575	63	683,048	0	59,222	3,026	620,799
29	2029	575	63	683,048	0	59,222	3,026	620,799
30	2030	575	63	683,048	0	59,222	3,026	620,799
31	2031	575	63	683,048	0	59,222	3,026	620,799
32	2032	575	63	683,048	0	59,222	3,026	620,799
33	2033	575	63	683,048	0	59,222	3,026	620,799
34	2034	575	63	683,048	0	59,222	3,026	620,799
35	2035	575	63	683,048	0	59,222	3,026	620,799
36	2036	575	63	683,048	0	59,222	3,026	620,799
37	2037	575	63	683,048	0	59,222	3,026	620,799
38	2038	575	63	683,048	0	59,222	3,026	620,799
39	2039	575	63	683,048	0	59,222	3,026	620,799
40	2040	575	63	683,048	0	59,222	3,026	620,799
41	2041	575	63	683,048	0	59,222	3,026	620,799
42	2042	575	63	683,048	0	59,222	3,026	620,799
43	2043	575	63	683,048	0	59,222	3,026	620,799
44	2044	575	63	683,048	0	59,222	3,026	620,799
45	2045	575	63	683,048	0	59,222	3,026	620,799
46	2046	575	63	683,048	0	59,222	3,026	620,799
47	2047	575	63	683,048	0	59,222	3,026	620,799
48	2048	575	63	683,048	0	59,222	3,026	620,799
49	2049	575	63	683,048	0	59,222	3,026	620,799
50	2050	575	63	683,048	0	59,222	3,026	620,799

EB/C=	3.7
ENPV=	3,150,983
EIRR=	10.4%

Table K.3.2 Economic and Financial Sensitivity Analysis

Year		Area (ha)		Fiancial					Economic				
				Benefit -10%		Cost +10%		B-10%-C+10%	Benefit -10%		Cost +10%		B-10%-C+10%
		with	out	B:-10%	B(-10%)-C	C:+10%	-C(+10%	B-10%-C+10%	B:-10%	B(-10%)-	C:+10%	B-C(+10%	B-10%-C+10%
1	2001	0	63	0	-3,382,870	3,721,157	3,721,157	-3,721,157	0	2,811,664	3,092,831	-3,092,831	-3,092,831
2	2002	0	63	0	-3,382,870	3,721,157	3,721,157	-3,721,157	0	2,811,664	3,092,831	-3,092,831	-3,092,831
3	2003	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
4	2004	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
5	2005	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
6	2006	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
7	2007	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
8	2008	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
9	2009	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
10	2010	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
11	2011	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
12	2012	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
13	2013	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
14	2014	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
15	2015	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
16	2016	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
17	2017	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
18	2018	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
19	2019	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
20	2020	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
21	2021	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
22	2022	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
23	2023	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
24	2024	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
25	2025	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
26	2026	575	63	550,849	303,338	272,262	339,792	278,587	614,743	400,585	235,573	447,474	379,170
27	2027	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
28	2028	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
29	2029	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
30	2030	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
31	2031	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
32	2032	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
33	2033	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
34	2034	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
35	2035	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
36	2036	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
37	2037	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
38	2038	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
39	2039	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
40	2040	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
41	2041	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
42	2042	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
43	2043	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
44	2044	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
45	2045	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
46	2046	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
47	2047	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
48	2048	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
49	2049	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269
50	2050	575	63	550,849	480,348	77,551	534,503	473,298	614,743	552,494	68,474	614,574	546,269

Financial	Base	10%	Cost
Base	7.4%	6.6%	
-10%	6.5%	5.7%	

Econmic	Base	10%	Cost
Base	10.4%	9.3%	
-10%	9.2%	8.3%	

Table K.3.3 Financial Evaluation of the Project

Table K.

Year		Area (ha) with	Area (ha) out	Direct Benefit (with)-(out)	ther Benefi transport	Financial Benefit	Investment F C	Investment: L/C Major Portion	Investment: L/C Unskilled Labor	Taxes	O&M Cost	Cost Total	Financial Cash Flow
1	2001	0	63	0	0	0	1,831,777	1,036,577	150,130	361,386	0	3,382,870	-3,382,870
2	2002	0	63	0	0	0	1,834,777	1,036,577	150,130	361,386	0	3,382,870	-3,382,870
3	2003	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
4	2004	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
5	2005	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
6	2006	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
7	2007	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
8	2008	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
9	2009	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
10	2010	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
11	2011	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
12	2012	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
13	2013	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
14	2014	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
15	2015	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
16	2016	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
17	2017	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
18	2018	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
19	2019	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
20	2020	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
21	2021	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
22	2022	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
23	2023	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
24	2024	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
25	2025	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
26	2026	575	63	571,430	40,625	612,055	128,210	27,240		27,061	65,000	247,511	364,544
27	2027	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
28	2028	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
29	2029	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
30	2030	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
31	2031	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
32	2032	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
33	2033	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
34	2034	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
35	2035	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
36	2036	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
37	2037	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
38	2038	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
39	2039	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
40	2040	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
41	2041	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
42	2042	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
43	2043	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
44	2044	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
45	2045	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
46	2046	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
47	2047	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
48	2048	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
49	2049	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
50	2050	575	63	571,430	40,625	612,055				5,501	65,000	70,501	541,554
												FB/C=	2.8
												FNPV=	1,010,245
												FIRR=	7.4%

Table K.3.4 Average Household Economy in the Project Area
(Satellite Farm)

Average household: Family size is six and economically active member are three

(1) Unit (ha/season) Cost and Income with Transplanting Method

Unit yield is 5.5 ton/ha, and unit farm gate price is 157 F.CFA/kg

(Unit: F.CFA)

Production Cost		Sale	
Hire Charge of Cultivator*2	98,400	Paddy	863,500
Seed	10,500		
Fertilizer + Herbicide	85,370		
Labour for canal O&M	204,520		
Water charge	50,000		
Total Cost	448,790	Net Income	414,710
		Net Income*1	619,230

Notes:
*1:Labor fully managed by family and COOP.
*2 Depreciation cost of cultivator (30,000 F.CFA/ha) is included

(2) Unit (/ household) Cashflow from Paddy Double Cropping

Assumption : Harvest area 1.5 ha, production 16.5 ton/year and self-consumption 0.2 ton/head/year (1.2 ton/year/household), then marketable paddy is estimated at 15.3 ton/year/household

(Unit: F.CFA)

Sale Paddy	15.3	ton
Gross Income = Sale	2,402,100	CFA franc
Production Cost =1.5ha x (448,790 – 204,520)	-732,810	
Irrigation Water Rate*	-8,000	
Co-op Membership Fee/year	-12,000	
Co-op Commission (1 % of Sale)	-24,021	
Net Farm Income	1,625,269	CFA franc
Amortization (15 Years) =(3,000,000 x 0.9)/15	180,000	
Interest Payment (2%/year)	54,000	(First Year)
Debt Service of Housing Loan	234,000	14%
Saving (10% of Net Farm Income)	162,527	10%
Annual Disposable Income	1,228,742	76%

Notes : *: =10bil(dam) X 1%(of useful life) X 5%(allocated for irrigation) X 60.5% (=575/950:area ratio) /384(households)

L: FIELD SURVEYS

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L.1 Topographic Survey

L.1.1 Aerial Photographic Survey

(1) Purpose and Scope of Works

The aerial photography and the uncontrolled mosaic were carried out in order to prepare topographic data necessary for the implementation of the Study, and the following works were conducted by sub-contracting the local surveyors.

- Mobilization/demobilization of Aircraft and Crew: Lump Sum
- Aerial photography with the scale of 1:10,000: 120 line km
- Uncontrolled mosaic with the scale of 1:10,000: 146 photo frames

These works cover all of the Study Area of about 13,000 ha. The works were completed successfully in February to March 1998.

(2) Manners of Aerial Photographic Survey

The site of the Study Area and the flight route for shooting were confirmed on the available topographic maps with the scale of 1:50,000 and some site reconnaissance survey in the area. Black and white aerial photographs at a scale of 1:10,000 covering in a total of 120 line km were taken, and the mosaic was prepared with these aerial photos in the manners as stated bellow.

1) Mobilization

An aircraft, its crew and other necessary equipment and materials was mobilized to the San-Pédro Airport, and all the necessary site arrangements, checking and maintenance of equipment, and test flight(s) were carried out.

2) Aerial Photo Shooting

The aerial photo shooting was carried out by a local contractor under the supervision of the Study Team. An aerial photo camera with wide-angle lens of 150 mm focal distance was used for shooting at a flight altitude of 1,500 m, and black and white photographs were taken on a scale of 1/10,000. The shooting was conducted setting the eight (8) flight course as shown in Fig. L.1.1, to cover the area of about 13,000 ha along the San-Pédro river including the Study Area of 10,000 ha.

3) Setting-up of Pass Points

The pass points were set up to cover the Study Area of 10,000 ha including the priority project areas. Six (6) points were marked at site by installing the stone posts.

4) Preparation of Photo Mosaic

The photo mosaic was prepared using the aerial photographs (contact photograph) of 1/10,000 scale to cover about 13,000 ha including the Study Area of 10,000 ha. The prepared photo mosaic is of an uncontrolled one that does not require any adjustment of scales and directions. The names of places and villages and the other notes and

information were mentioned in the mosaic based on the existing 1/50,000 topographic maps.

(2) Results of Survey

1) Bench Marks and Referred Points

The following table presents the major survey points referred and established in the survey works.

List of Existing and Established Bench Marks

Name of Bench Mark	Coordinates** X (East)	Y (North)	Elevation (m)	Name of Bench Mark	Coordinates** X (East)	Y (North)	Elevation (m)
PN 19	-	-	29.904	GPS 6*	546120.054	761431.989	12.875
PN 24	-	-	19.460	GPS 7*	550122.330	760389.434	24.743
PN 26	-	-	13.171	GPS 8*	533297.082	759781.926	6.176
PN 27	-	-	7.936	GPS 9*	537727.108	761232.062	20.944
PN 28	-	-	5.722	GPS 10*	542754.895	762179.546	12.341
PN 29	-	-	13.262	GPS 11*	549161.828	761630.992	30.330
PN 28-C	-	-	5.680	GPS 12*	545600.634	764561.095	31.331
GPS 1*	525878.832	764518.104	5.235	GPS 13*	545563.741	766269.836	27.524
GPS 2*	529684.730	760942.408	6.621	GPS 14*	538714.409	764943.108	22.893
GPS 3*	530663.540	758022.590	4.813	GPS San-Pédro	526887.349	761014.602	-
GPS 4*	534317.296	758244.882	7.800	GPS Sassandra	546858.787	822237.787	-
GPS 5*	540409.600	760742.369	13.711	-	-	-	-

Note: *: Newly established points.
**: Coordinates are expressed in WGS84 and UTM Abidjan grid system.

14 GPS points were established in the survey works together with the other minor bench marks on the survey route. The coordinates of these points were measured by the GPS static survey referring to two (2) national GPS points in San-Pédro and Sassandra. Their elevations were measured by the leveling survey referring to the existing national bench marks such as PN 19, PN 24, PN 26, PN 27, PN 28, PN 29 and PN 28-C. The coordinates are expressed in WGS84 and UTM Abidjan grid system, while elevations in meters above mean sea level. The locations of these points are indicated in Fig. L.1.1.

2) Prepared Topographic Maps and Photo Mosaic

The following maps and drawings were prepared as a result of the aerial photographic survey.

- Uncontrolled photo mosaic with a scale of 1:10,000
- Topographic maps with a acale of 1:10,000 consisting of eight (8) sheets to cover whole of the Study Area
- Topographic maps with a scale of 1:5,000 consisting of four (4) sheets to cover the selected Priority Project Area
- Aerial photos of 146 sheets, of which photo numbers prepared for each flight run are as follows:

Number of Photos for Each Flight Run

Run 1	14	Run 3	12	Run 5	24	Run 7A	17	Run 8	10
Run 2	13	Run 4	25	Run 6	25	Run 7B	6	Total	146

The area covered by each sheet of topographic map is indicated in Fig. L.1.1 for both of scales of 1:10,000 and 1:5,000. The topographic maps prepared in the aerial photo survey are attached to Volume II of this report.

L.1.2 Cross-section and Longitudinal Profile Survey of the San-Pédro River

The river profile and cross-section survey was carried out along the San-Pédro river course to determine the location of intake site for irrigation. Each intersection point in profile and cross-section under and above the river water surface were measured by terrestrial survey method, and the profile and cross-section drawings were prepared. The bench marks and the GPS points established were utilized for this survey work as much as possible.

The locations of the measured cross-sections are indicated in Fig. L.1.2 and the coordinates of their control pegs are listed in the following table.

Section	X (East)	Y (North)	Section	X (East)	Y (North)	Section	X (East)	Y (North)
00e	766,130.153	526,237.142	16e	757,376.265	531,806.359	25e	758,194.438	536,584.130
03w	763,403.033	526,035.573	17e	757,579.733	532,274.508	26w	758,879.472	537,197.823
04w	763,203.098	526,762.986	18e	757,361.735	532,951.436	27e	759,206.592	537,573.773
05e	762,561.533	527,495.048	19e	757,446.199	533,414.830	28w	759,521.264	538,253.626
06e	762,156.006	528,329.905	20e	757,497.989	533,824.999	29e	759,640.347	538,985.139
07w	762,129.568	529,249.879	21aw	758,001.827	534,382.232	30w grd	759,960.381	539,617.228
08w	761,367.269	529,327.469	21e	757,675.200	534,399.060	31e top	759,912.322	540,428.980
08w	761,373.903	529,325.444	23e	757,406.831	535,631.807	31w grd	759,848.841	540,431.084
09w	760,635.022	529,841.971	22w	757,771.434	534,977.839	32w top	760,197.293	541,255.729
10e	759,977.093	529,665.473	23w	757,344.392	535,675.925	33e top	760,463.756	542,040.420
11w	759,490.117	529,773.339	24a mid	758,122.035	536,300.163	35w	761,499.552	542,437.014
12e	758,819.699	529,914.419	24w	757,640.497	536,150.924	36w	761,865.910	542,594.090
13w	758,424.271	530,616.144	25ae	758,726.466	536,905.356	37e rep	761,998.763	543,257.848
14w ps	758,035.375	530,680.467	25be	758,837.454	536,981.403	37w	761,904.437	543,189.631
15w	757,362.999	531,014.702	25ce	758,952.926	537,104.772	-	-	-

The following cross-sections and longitudinal profiles were prepared.

- Longitudinal profile of about 49 km with the horizontal and the vertical scales of 1:100,000 and 1:200, respectively.
- Cross-sections with an interval of 1,000 m and the horizontal and the vertical scales of 1:500 and 1:100, respectively (150 m wing widths are taken for both banks of the river).

The prepared cross-sections and longitudinal profiles of the San-Pédro river are compiled in Volume II of this report.

L.1.3 Cross-section and Longitudinal Profile Survey of the Irrigation and Drainage Canals for the Priority Project Area

To facilitate the planning in the Feasibility Study of the Priority Project Area, cross-section and longitudinal profile survey of the existing irrigation and drainage canals as well as the proposed route of the Grand Canal by the terrestrial survey method. The bench marks and the pass points established were utilized for this survey work as much

as possible.

The routes of the surveyed canals are indicated in Fig. L.1.3 for the existing canals in the Study Area and Fig. L.1.4 for the Grand Canal, and the following cross-sections and longitudinal profiles were prepared.

1) Grand Canal from the San-Pédro Dam to the Priority Project Area
- Longitudinal profile of about 18.2 km with the horizontal and the vertical scales of 1:5,000 and 1:100, respectively.
- 100 m wide cross-section with an interval of 100 m and the horizontal and the vertical scales of 1:200 and 1:100, respectively.

2) Irrigation and Drainage Canals in the Priority Project Area
- Longitudinal profile with the horizontal and the vertical scales of 1:1,000 and 1:100, respectively.
- 50 m wide cross-section with an interval of 50 m and the horizontal and the vertical scales of 1:100 and 1:100, respectively.

The approximate distances of the surveyed irrigation and drainage canals are tabulated below.

Distances of Surveyed Irrigation and Drainage Canals

Name of Route	Surveyed Distance (m)	Name of Route	Surveyed Distance (m)	Name of Route	Surveyed Distance (m)
Irrigation Canals		CP 221	2,580.0	Drainage Canals	
CP 0	204.6	CP 222	3,116.0	DP 1	1,894.0
CP 1	3,194.6	CP 3	850.7	DP 2	3,195.2
CP 2	557.4	CP 31	407.4	DP 3	658.1
CP 21	1,052.7	CP 311	980.2	DP 4	1,735.0
CP 211	2,467.9	CP 32	1,012.4	DP 5	2,180.0
CP 212	1,250.0	-	-	DP 6	2,378.0
CP 22	2,014.3	Total	19,688.2	Total	12,040.3

The prepared longitudinal profiles and cross-sections are attached to Volume II of this report.

L.2 Soil Survey

L.2.1 ORSTOM Soil Survey

In 1968, ORSTOM made the reconnaissance soil survey for confirming the agricultural potential development in San-Pédro. The reconnaissance morpho-pedological survey of the remaining area of the Study Area, except for Port Authority Expansion Area covering 6,000ha, was conducted by the Pedology Center of BNETD under the supervision of JICA Study Team. The survey included the confirmation of soil physical and chemical properties in the above ORSTOM surveyed San-Pédro Paddy Project Area. ORSTOM classified the San-Pédro Paddy Project Area into six soil groups. BNETD has prepared pedolo-mophological map covering 6,000ha of additional survey area and the

area surveyed by ORSTOM. BNETED has classified the area into 13 pedolo-mophological groups.

L.2.2 BENETED Morpho-pedological Survey

(1) Vegetation and Occupation of the Soils

The zone of SAN-PEDRO belongs to the ombrophilous sector which is the area for the dense forest sempervirente. But this forest made place for hévéaculture and cacao cultures long before and recently for coffee culture. One can observe some small plots of forests in the central part of the zone and in particular in the field reserved for the IDEFOR and a large part of lowlands in the Northern part is still found unexploited.

- The plantations of annual cultures are found rare and limited to the low slopes of hills. The lowlands are generally found in rice cultivation.
- The natural vegetation and the local ecology of the zone have been found largely modified by human factor.

(2) Geomorphology and Landform

The area of San-Pédro is a zone of rather low altitude but its relief is stiff. One can distinguish 3 landforms from the geomorphological point of view.

- at the edge of the road San-Pédro - Soubré and in the Central part of the zone, we find one landform of individual hills with narrow and almost flat tops but stiff slopes with an elevation of 15 to 30 m from ground surface;
- at the edge of the San-Pédro river, a succession of small hills or convex hilly lands with plano-convex of narrow tops also but with an elevation lower than the first;
- a vast plain in the southern part of the zone and along the San-Pédro river.

Between the various hills and the almost flat-topped convex croups in the convex part, one observes lowlands with planed landform and sometimes boxed.

(3) Soils

(a) Methodology

1) Basic Concept

The concept which makes the base for this morpho-pedological study with the scale of 1/50.000 site for the Rural Development Project of the Plain of San-Pédro was underlined by the pedologists of ORSTOM and IRAT on the close relation existing between the landforms (geomorphology) and the soils (pedology) in the inter-tropical areas. Indeed the toposéquentielle organization of the soils in these areas caused difficulties in making their zoning representatives. The applied method, therefore, is based on the study of a certain number of varied representative topo-sequences from their distribution areas and from the various types of landscapes (or interfluves presenting the identical characteristics) recognized by photo-interpretation and from field works; then with the extrapolation of the results by a whole combination-comparison of the geo-phyto-morphological identical together-settings.

2) Study-Implementation

The whole work attributing to the realization of the morpho-pedological reconnaissance study includes the field work, the office work and the laboratory work.

i) Office works

The office works comprise:

- Preparatory works
- Laboratory analyses
- Data renumeration
- Preparation of the reports

a) Preparatory works

Preparatory works cover the review and collection of the related documents served as the database so that the elaboration of these materials can establish a draft basic map to be used as the basic document for the field study.

Also a reconnaissance visit of the site to establish the existing poles of investigation starting from the infrastructure can be made in this period. Thus within the framework of this first period, the aerial photographs of 1/50.000 scale, the maps of 1/50.000 and a map of 1/200.000 of the study zone were collected by the contractor. He was then proceeded the study of these documents, in particular the photo-interpretation of the aerial photographs and the data on a basic map of 1/50.000. It is starting from this document that were fixed a certain number of spots for making the study of topo-sequences in connection with the various types of locations or landforms.

b) Analyses of laboratory

From the field works, the soil samples were taken from the soil profiles of the representative types of soils described in the study zone for the laboratory analysis. They are analyses to determine the physical and chemical characteristics of soils. The analyses carried out by the Soil Analysis Laboratory of soils, water and plants of the Unit of Pedology Applied of BNETD are:

- measurement of the pH (water and Kcl)
- determination of total phosphorus by nitric method using sulphuric medium and colorimetric measurement,
- determination of assimilable phosphorus by the method of BRAY,
- determination of the organic matter or total carbon by the method of WALKLEY and BLACK or by the method of ANN,
- determination of total nitrogen by mineralisation followed by distillation then proportioning,
- determination of the cation capacity of exchange (C.E.C),
- determination of the exchangeable bases (Ca^{++}, Mg^{++}, K^{+}, Na^{+}), etc.
- measurement of the electrical conductivity of extracts (C.E.E.)

c) Elaboration of data

At the end of the study, a certain number of data regarding the survey site

(determination of the survey tracks, description sheets of the soil profiles, analysis sheets, observation remarks) were obtained. From the whole combining elaboration of these data with the remarks and observations made by the study group of technicians, the final map will be established and the preparation of the reports can be proceeded.

In this study, the elaboration of data will need to interpret again the aerial photos of 1/10.000 provided by JICA in order to supplement and to improve the insufficient information obtained from the photographs of 1/50.000 scale which could not cover all the details of the area.

d) Preparation of the reports
In principle, at the end of the study, it is necessary to concentrate all the observations and conclusions on the study.

ii) Field works
In order to confirm the assumptions from the photo-interpretation, to proceed the collection of pedological data of the various morpho-pedological units, and to carry out the sampling of the soil profiles, standards or representatives of the soil types or the cartographic units in the study zone.

The field works consist of:

- the opening of transects or tracks by diggers based on a plan established by the pedologist implying the density of observations and required information. The density is based on the scale of the study;
- with the digging of a few hundreds of pedological pits (or profiles) having 70 cm-width and 150 cm-depth which descriptions are ensured by soil surveyors and the engineer;
- the sampling soil samples, the determination of representative profiles.

Diggers and soil surveyors, as well as the pedologist are mutually cooperated in their task by composing a working team occasionally consisted of about thirty people.

During this phase, 25 survey tracks in total were made with a length varying between 1.000 and 3.500 m. At these tracks the pedological profiles were dug by intervals of 100 to 200 m. This interval distance was made in connection with the complexity or the heterogeneity of the soils.

Each profile was described by using a standardized sheet notifying all the environmental parameters (topography, approximate inclination of the slope, vegetation) and soil (depth, color, texture, structure, porosity, rooting, consistence).

Among these profiles, about twenty samplings were made for the analysis in laboratory, based either on their representatives of soil characteristics, or on their locations in the landscape (top, slope, lower part of slope, lowland).

Field works were proceeded over three weeks and mobilized in fulltime one engineer

and 6 technicians with the technical assistance of 2 pedologists for one week.

iii) Laboratory analysis
With the execution of field works, soil samples were collected with the determination of representative profiles of the soil types of soils in the study zone for the laboratory analysis. The analyses were to determine the physical and chemical characteristics of soils. The analyses carried out by the Analysis Laboratory of soils, water and plants of the Unit of Pedology Applied of BNETD are:

- measurement of the pH (water and Kcl)
- determination of total phosphorus by nitric method by using sulphuric medium and colorimetric measurement,
- determination of assimilable phosphorus by the method of BRAY,
- determination of the organic matter or total carbon by the method of WALKLEY and BLACK or by the method of ANN,
- determination of total nitrogen by mineralisation followed by distillation then proportioning,
- determination of the cation capacity of exchange (C.E.C),
- determination of the exchangeable bases (Ca^{++}, Mg^{++}, K^{+}, Na^{+}), etc.

a) Elaboration of data
At the end of the study, a certain number of data regarding the survey site (determination of the survey spots, description sheets of the soil profiles, analysis sheets, observation remarks) were obtained. From the whole combining elaboration of these data with the remarks and observations made by the study group of technicians, the final map will be established and the preparation of the reports can be proceeded.

In this study, the elaboration of data will need to interpret again the aerial photos of 1/10.000 provided by JICA in order to supplement and to improve the insufficient information obtained from the photographs of 1/50.000 which could not cover all the details of the area.

b) Preparation of the reports
In principle, at the end of the study, it is necessary to concentrate all the observations and conclusions on the study.

In this study, JICA asked for the preparation of an Interim Report and a Final Report.

(b) Results
With the implementation of the study, a map of 1/20.000 (presentation scale) was established from the photo-interpretation of the aerial photographs of 1/10.000, the topographic map and the field observations as shown in Fig. L.2.1. Indeed the map of 1/50.000 (study scale) would not very readable because of the presence of some very small cartographic units. It should be notified that this map was directly drawn from the aerial photographs and can display some distortions when comparing to a topographic base map of the same scale. However it has the advantage of being a little more expressive and in conformity with the field reality.

It is a map of morpho-pedological units with a legend describing each morpho-pedological unit or cartographic unit of the dominant soil types, their general characteristics and the principal constraints, which constitute the final results of this pedological study.

The study of 1/50.000 of the site of the Integrated Rural Development Project of the Plain of San-Pédro made it possible to highlight two great morpho-pedological sets, except the alluvial plain of the San-Pédro river and of its numerous affluents.

The first set represented by a whole interfluve of cuts with stiff slopes consists of individual hills subdivided in high and low hills. This distinction is based on the amplitude of various hills, but especially on the stiff slope which is a very important element in the land utilization of the site subjected to study.

The second set is consisted of a succession of convex croups to plano-convex with reduced tops. Three types of this landform were identified. The first is the original shape presenting of the slopes with little to average inclination. The second presents slopes to relatively sharp inclination. And finally the last type is identical to the second but with rock exposures on top and slope.

1) Description of the cartographic units

i) Definition

The cartographic unit (U.C) is a morpho-pedological unit cartographiable on the study scale; i.e. representable in a visible way on the map. It represents the volumous presence in nature and a description area on the map showing a geomorphological homogeneity with similar pedological characteristics.

The cartographic unit can be subdivided into segments; a segment being a significant portion of the U.C with particular characteristics.

Denomination of an U.C (example: U.C 18), results from former works completed by the pedologists of IRAT and ORSTOM which led to the establishment of a coding of the landscapes and cartographic units studied during the morpho-pedological study of the areas of savanna of North. This coding was reviewed and completed by the pedologists of BNETD for the areas of savanna and forest.

ii) UNIT CARTOGRAPHIC 18: high hills or hills with stiff slope made of deterioration of schistous or volcanogenic rocks

The zone of San-Pédro comprises a whole interfluve consisted of individual hills at plano-convex tops with rather reduced convex (30 to 50 cm of width) and with sharp and sometimes stiff slope (> 30 %). The two segments of this cartographic unit were indicated by S 18 and V 18. The top of (S 18) consists of not very deep soils to fairly deep, more or less mixed with small gravel, argilo-sandy with argilo-sablo-muddy, resting on the faded rock-mother or in process of deterioration.

On the slope (V 18), the soils are a little deeper so that the faded rock-mother appears

on average depth or in-depth.

iii) UNIT CARTOGRAPHIC 19: low hills with sharp slope made of deterioration of schistous or volcanogenic rocks

They show practically the same characteristics as the high hills but the inclination of the slopes are lesser, i.e. relatively less accidental (20 - 30 %). The tops are relatively wider but their width seldom reaches 100 m. The U.C 19 was also subdivided into 2 segments: S 19 (top) and V 19 (slope). On the top as on the slopes, the soils are deep or fairly deep, red, more or less mixed with small gravel, argilo-sandy with argillaceous, resting on the rock-mother in course of deterioration.

iv) UNIT CARTOGRAPHIQUE.20: (glacis of mountain foot or slope of high and low hills)

The hills (high and low) have slopes which often go down in an abrupt way toward the lowland. That causes difficulties in the delimitation of the glacis at mountain foot. On the field one can observe sometimes a gradual passage but that is difficult to encircle in photo-interpretation. However, the space between a hill and another, when being joint they can be assimilated as the cartographic unit of U.C 20.

The soils are deep, red, more or less mixed with small gravel, sablo-argillaceous with argilo-sandy, resting on an armour, a carapace or the rock-mother in course of deterioration.

v) UNIT CARTOGRAPHIC 22: alluvial plain of the San-Pédro river and its affluents and large lowlands

A large alluvial plain is stretched along the San-Pédro river, interupted sometimes by convex hilly lands with plano-convex. It presents a landform generally plane but comprise at certain places of the microreliefs made up of scraps of " up lands " in the form of island or pads of bank.

One can generally observe soils of deep, hydromorphic, argillaceous soils with argilo-muddy, but also with sablo-argillaceous texture and even sandy.

vi) UNIT CARTOGRAPHIC 26: tops of interfluves of the convex hilly lands to plano-convex in forest zone without rock exposures

The tops of together setting of the convex croups to plano-convex make a landform with plano-convex. They are as reduced as in the case of the hills and seldom reach 50 m of width. They consist of generally deep, red more or less mixed with small gravel, argilo-sandy soils with argillaceous, laying sometimes on the rock in deterioration or the carapace or the armour.

This cartographic unit presents a type in the study zone. They are tops of plane together setting to plano-convex with gathered or scattered rock exposures. This type was indicated as U.C 26a. Nevertheless in these zones with rock exposures, the soils are deep and have a clay rate higher than 25 %. But the blocks of rocks exposed on soil surface are a constraint for farm mechanization.

vii) UNIT CARTOGRAPHIC 27: slopes of the convex croups with plano-convex in forest zone

The convex croups with plano-convex comprise three kinds of slopes. One distinguishes:

- slopes with gentle inclination with average (5 to 8 %); indicated as U.C 27;
- slopes with relatively stiff inclination (10 to 15 %) indicated as U.C 27c;
- slopes with relatively stiff inclination, with rock exposures indicated as U.C 27c/a;

On these slopes the soils are deep, red, argilo-sandy with argillaceous, more or less mixed with small gravel, laying on the rock in deterioration. But on downstream of each unit the soils can be limited by a carapace or an armour. Moreover, the sharp inclination of the slopes is a constraint for farm mechanization.

viii) UNITS CARTOGRAPHIC G then S: gentle inclination and lowlands of the zones with substratum of granitic or granitoid rocks then low of slopes and lowlands of the zones with substratum of schistous or volcanogenic rocks

The study zone is well drained. Many narrow lowlands were observed there. On the cartographic level, these lowlands were gathered with bottoms of slope in the same unit. According to the nature of the rock-mother or geological substratum, two distinctions were made:

- bottoms of slope and lowland on substratum of granitic rocks or related rocks (U.C G);
- bottoms of slope and lowland of the zones with substratum of schistous or volcanogenic rocks, (U.C S).

The soils are relatively more clayey in bottoms of slope and lowland on schist that in the low slopes and lowlands on granite or granitoid.

REMARKS

The Cartographic Unit 31 indicating the low terrace was voluntarily occulted in this study because only one profile on only one spot made it possible to highlight the presence average depth of some rollers. Moreover the use of this unit would be close to that of the alluvial plain (U.C 22).

(4) Overall Characteristics of the Cartographic Units (U.C) and their Agronomic Values

The cartographic units described in the preceding paragraph have particular characteristics which are related on their topographic position and their soil composition. The general characteristics of the dominant soils and the principal constraints related to these soils make it possible to determine the relative values of these soil units. The evaluation of this relative value is primarily based on the following criteria:

- useful depth of the soil,
- pierrosity of surface,
- texture of the soil,
- content of coarse elements,

- hydromorphy,
- topography (slope).

The chemical criteria which are relatively easier subjected to correct and modifiable during and after the development were voluntarily isolated for the determinations of the agronomic values of the cartographic units.

It should be notified that the agronomic values allotted to U.C are only one indicator. Only studies of related details will allow to determine the farming aptitudes of the soils while specifying:

- types of plants,
- systems of installation,
- farming methods adapted on the soil or sets of mapped soils

Thus the agronomic values given in the present study have the following significance:

Good: More than 70 % of the surface of the U.C could be suited to the culture after a pedological study of detail. Enough good: 50 % to 70 % of the surface of the U.C could be suited to the culture after a pedological study of details.
Passable: 30 to 40 % of the surface of the U.C could be suited to the culture after a pedological study of details.
Poor: 10 to 20 % of the surface of the U.C could be suited to the culture after a pedological study of details.
Bad: Less than 10 % of the surface of the U.C could be suited to the culture after a pedological study of details.

(a) U.C 18 (high formed hills of deterioration of schistous rocks or volcano-sedimentary

i) S 18 (summit part of the U.C 18)

a) Physiography

Summit of interfluve to plane landform with plano-convex on surface generally reduced to weak slope with average (0 - 8 %).

b) Typology of the soils and their representativeness in the U.C

altered renovated Soils, fererallitic	35 %
renovated altered Soils ,ferrallitic	30 %
renovated and altered typical Soils, ferrallitic with covering with renovated facies	20 %
modal altered Soils ferrallitic	10 %
Others	5 %

c) General Characters of the soils

Soils not very deep, fairly deep and deep, brown reddish with yellowish, mixed with small gravel, argilo-sandy red with argilo-muddy, often resting on the faded rock or in deterioration.

d) Principal constraints
Often reduced depth. Sometimes excessive Gravel mixing.
Difficulties of access. Presence of very stiff microrelief.

e) Relative Value of the soils
Agricultural value of the rather good unit

Item	Evaluation
Mechanization	poor
Traditional agriculture	enough good
Perennial culture	enough good
Forestry	enough good
Breeding	poor

ii) V 18 (lower part of the U.C 18)
a) Physiography
High hills with stiff slope > 30 %

b) Typology of the soils and their representatives in the U.C

altered renovated soils, ferrallitic	30 %
renovated altered soils, ferrallitic	25 %
renovated and altered typical soils, ferrallitic with covering with renovated facies	15 %
modal altered soils, ferrallitic	15 %
Others	10 %

c) General characters of the soils
Fairly deep, deep soils and even not very deep, with or without small gravel mixing, sandy clayey with clayey sandy and argillaceous, laying on the rock in deterioration.

d) Principal constraints
Depth rather often reduced. Sometimes excessive gravel mixing.
Stiff slope. High risk of erosion in ravine. Clogging and induration downstream from the unit.

e) Relative Value of the soils
Agricultural value of the passable unit to poor

Item	Evaluation
Mechanization	bad
Traditional agriculture	passable
Perennial culture	passable
Forestry	enough good
Breeding	bad

(b) U.C 19 (formed low hills of deterioration of schistous or volcanogenic rocks)
i) S 19 (summit part of the U.C 19)
a) Physiography
Summit of plane interfluve in convex plan

b) Typology of the soils and their representativeness in the U.C

altered renovated soils, fererallitic	30 %
renovated altered soils, ferrallitic	25 %
renovated and altered typical soils, ferrallitic with covering with renovated facies	25 %
modal altered soils, ferrallitic	15 %
Others	5 %

c) General characteristics of the soils

Soils not very deep, fairly deep and deep, mixed with small gravel, clayey-sandy with clayey-muddy often resting on the faded rock or in the course of deterioration.

d) Principal constraints

Often reduced depth. Sometimes excessive gravel-mixing. Difficulty of access

e) Relative value of the soils

Agricultural value of the rather good unit to poor

Item	Evaluation
Mechanization	Poor
Traditional agriculture	Good
Perennial culture	Enough good
Forestry	Good
Breeding	Poor

ii) V 19 (lower part of U.C 19)

a) Physiography

Pouring low hills with strong slope 20 to 25 %

b) Typology of the soils and their representativeness in the U.C

altered renovated soils, fererallitic	30 %
renovated altered soils, ferrallitic	20 %
renovated and altered typical soils, ferrallitic with covering with renovated facies	20 %
modal altered soils, ferrallitic	10 %
Others	5 %

c) General characters of the soils

Soils deep and fairly deep, with or without gravel mixing, sometimes gravelly, clayey sandy with clayey muddy, laying on the faded rock-mother or in the course of deterioration.

d) Principal constraints

Sometimes excessive gravel-mixing. Sometimes reduced depth. Stiff slope
Risk of erosion by water

e) Relative Value of the soils

Item	Evaluation
Mechanization	poor
Traditional agriculture	enough good
Perennial culture	enough good
Forestry	good
Breeding	poor

(c) U.C 20 (glacis of Piedmont or slope high and low hills)

a) Physiography

Glacis of Piedmont, high and low hills.

b) Typology of the soils and their representativeness in theU.C

Modal altered Soils, ferrallitic	25%
Typical and altered Soils, ferralllitic with covering	25%
Colluvionnés altered Soils, ferrallitic modal	20%
Colluvionnés altered Soils, ferrallitic hardened	15%
Colluvionnés altered Soils, ferrallitic hydromorphic	10%
Others	5%

c) General Characters of the soils

Soils deep and fairly deep with depth sometimes limited by an armour or a carapace, mixed with small gravel, sometimes gravelly and clayey-sandy with argillaceous

d) Principal constraints

Sometimes excessive gravel-mixing

Reduced depth

Clogging sometimes present downstream from the unit.

e) Relative Value of the unit

Agricultural value of the rather good unit to passable

Item	Evaluation
Mechanization	enough good with passable
Traditional agriculture	good
Perennial culture	enough good with passable
Forestry	enough good
Breeding	enough good

(d) U.C 22 (alluvial plain and large lowlands)

a) Physiography

Alluvial plain of the San-Pédro river and its affluents, large lowlands, associated or not with the low terrace, generally plane landform.

b) Typology of the soils and their representativeness in the U.C

not very humus-bearing hydromorphic Soils with pseudo-gley	55 %
not very advanced Soils of alluvial contribution	25 %
not very advanced Soils of contribution colluvial	15 %
Others	5 %

c) General characters of the soils

Clayey-muddy deep soils with argillaceous but also with soils with sandy clayey texture and even sandy spreadings by places.

d) Principal Constraints

Texture sometimes heavy. Semi-permanent clogging. Texture sometimes sandy.

Speed of infiltration sometimes too high.Very low acidity sometimes

e) Relative Value of the unit

Agricultural value limited to the cultures tolerating clogging, in particular the legume

and the rice growing in lowland. These aptitudes are a primarily function of texture, useful depth of the soil, the pierrosity of surface, total porosity, the speed of infiltration, level of appearance of the soil water, the value of the pH, etc. Consequently:

Item	Evaluation
Mechanization	good with bad
Traditional agriculture	good with passable
Perennial culture	poor
Forestry	poor
Breeding	enough good with passable

(e) U.C 26 (top of interfluve of the croups with plane convex in forest zone without rock exposures)

a) Physiography

Summit of interfluve to plane landform in convex plan, of weak slope with average.

b) Typology of the soils and their representativeness in the U.C

altered renovated soils, fererallitic	35 %
renovated altered soils, ferrallitic	25 %
renovated and altered typical soils, ferrallitic with covering with renovated facies	15 %
modal altered soils, ferrallitic	10 %
Others	5 %

c) General Characters of the soils

Deep soils, brown reddish with reddish yellow, with or without gravel mixing, laying on the mother-rock in deterioration and sometimes on the carapace.

d) Principal Constraints

Generally negligible constraints but sometimes reduced depth

e) Relative Value of the unit

Agricultural value of the good unit to rather good

Item	Evaluation
Mechanization	enough good with good
Traditional agriculture	Good
Perennial culture	good with rather good
Forestry	Good
Breeding	enough good with good

(f) U.C 26a (top of interfluve of croups with plane convex in forest zone with rock exposures)

a) Physiography

Summit of interfluve to plane landform in convex plan, weak slope with average.

b) Typology of the soils and their representativeness in the U.C

modal altered Soils, ferrallitic and altered modal with hardened facies	35%
renovated altered Soils, ferrallitic	35%
altered renovated Soils, ferrallitic	15%
modal typical Soils, ferrallitic and altered with covering	10%
Others	5%

c) General characters of the soils
Almost identical that in the U.C 26

d) Principal constraints
Blocks of rocks on the surface

e) Relative Value of the unit
Agricultural value of the rather good unit to passable

Item	Evaluation
Mechanization	passable with poor
Traditional agriculture	enough good
Perennial culture	enough good with passable
Forestry	enough good
Breeding	enough good

(g) U.C 27 (slope of convex croups with plane convex in forest zone without rock exposures)

a) Physiography
Slope with modelled rectiligno-convex, weak slope with average (5 to 8%)

b) Typology of the soils and their representativeness in the U.C

modal altered Soils, ferrallitic	35 %
Renovated altered Soils, ferrallitic	25 %
altered renovated Soils, ferrallitic	15 %
modal typical Soils, ferrallitic and altered with covering	10 %
Colluvionnés altered Soils, ferrallitic modal, hardened, hydromorphic	10 %
Others	5 %

c) General characters of the soils
Deep soils, red-yellowish with reds, of texture from clayey-sandy to clayey, more or less mixed with small gravel.

d) Principal Constraints
Relatively negligible constraints

e) Relative Value of the unit
Agricultural value of the good unit

Item	Evaluation
Mechanization	enough good with good
Traditional agriculture	good
Perennial culture	good with rather good
Forestry	good with rather good
Breeding	good

(h) U.C 27c (slope of convex croups with plane convex in forest zone with relatively stiff slope)

a) Physiography
Slope with modelled rectiligno-convex with rather strong slope (10 to 15 %).

b) Typology of the soils and their representativeness in the U.C

modal altered Soils, ferrallitic	30 %
renovated altered Soils, ferraltitic	25 %
altered renovated Soils, ferrallitic	15 %
modal typical Soils, ferrallitic and altered with covering	15 %
colluvionnés altered Soils, ferrallitic modal, hardened, hydromorphic	10 %
Others	5 %

c) General characters of the soils
Idem that in the U.C 27

d) Principal constraints
Rather strong slope. Risk of erosion in aquifer and ravine.

e) Relative Value of the unit
Agricultural value of the good unit to rather good

Item	Evaluation
Mechanization	passable with rather good
Traditional agriculture	good
Perennial culture	good with rather good
Forestry	good with rather good
Breeding	enough good with passable

Any mechanization on this U.C requires an installation of anti-erosive devices

(i) U.C 27c/a (slope of convex croups in plane convex in forest zone with relatively strong slope and with rock exposures)

a) Physiography
Slope with landform rectiligno-convex irregular, rather stiff slope (10 to 15 %)

b) Typology of the soils and their representativeness in U.C

Renovated altered Soils, ferrallitic	30 %
modal altered Soils, ferrallitic	30 %
altered renovated Soils, ferrallitic	20 %
modal typical Soils, ferrallitic and altered with covering	10 %
colluvionnés altered Soils, ferrallitic modal, hardened, hydromorphic	5 %
Others	5 %

c) General characters of the soils
Idem that in U.C 27

d) Principal constraints
Presence of blocks of rocks on the surface. Rather strong slope. Risk of erosion in aquifer and even in ravine.

e) Relative Value of the unit
Agricultural value of the passable unit to rather good.

Item	Evaluation
Mechanization	poor with passable
Traditional agriculture	enough good with good
Perennial culture	enough good
Forestry	good
Breeding	passable

(j) U.C G (gentle slope and lowland of the zones with geological substratum of granitic or granitoid origin)

a) Physiography

Low slope to rectiligno-concave landform on upstream and lowland with plane downstream

b) Typology of the soils and their representativeness in U.C

Upstream;

modal colluvionnés altered Soils, ferrallitic and/or impoverished	30 %
hardened colluvionnés altered Soils, ferrallitic	25 %
colluvionnés altered Soils, ferrallitic hydromorphic	15 %
not very advanced Soils of contribution colluvial modal	20 %
not very advanced Soils of contribution colluvial hydromorphic	10 %

Downstream:

not very advanced Soils of contribution colluvial hydromorphic	50 %
not very advanced Soils of alluvial contribution hydromorphic	30 %
hydromorphic Soils with pseudo-gley	20 %

c) General characters of the soils

Upstream: Deep soils with fairly deep, mixed with small gravel or gravel, blocked in-depth, argilo-sandy with not very sandy clayey..

Downstream: Deep soils with varied depths but generally sandy texture with sandy clayey, often blocked.

d) Principal constraints

Upstream: Sometimes reduced depth.Rock exposures by places. Texture often sandy Temporary clogging

Downstream: Texture often sandy. Semi-permanent clogging

e) Relative Value of the unit

Upstream:

Agricultural value limited to the cultures tolerating clogging in particular legume and rice growing. These aptitudes are a primarily function of texture, useful depth of the soil, the pierrosity of surface, the depth level of the level of permanent clogging, etc. Consequently:

Item	Evaluation
Mechanization	good with poor
Traditional agriculture	good with passable
Perennial culture	passable with rather good
Forestry	passable with rather good
Breeding	enough good with passable

Downstream:

Idem with the upstream part except for the slope which is generally weak and the absence of the pierrosity for surface. But here the aptitude is also a function of total porosity and the speed of infiltration. Consequently:

Item	Evaluation
Mechanization	good with poor
Traditional agriculture	good with passable
Perennial culture	Poor
Forestry	Poor
Breeding	Passable

(k) U.C S (gentle slope and lowland of the zones with schistous or volcanogenic geological substratum)

a) Physiography

Low slope to rectiligno-concave (upstream) landform and lowland of plane (downstream).

b) Typology of the soils and their representativeness in U.C

Upstream;

modal colluvionnés altered Soils,ferrallitic	35 %
hardened colluvionnés altered Soils, ferrallitic	25 %
colluvionnés altered Soils, ferrallitic hydromorphic	15 %
not very advanced Soils of contribution colluvial modal	15 %
not very advanced Soils of contribution colluvial hydromorphic	10 %

Downstream:

not very humus-bearing hydromorphic Soils with pseudo-gley	55 %
not very advanced Soils of alluvial contribution hydromorphic	25 %
not very advanced Soils of contribution colluvial hydromorphic	20 %

c) General characters of the soils

Upstream: Deep soils or little with fairly deep, more or less gravillonnaires, sometimes gravelly, limited in-depth by the armour, the carapace or the rock in deterioration.

Downstream: Deep, sandy clayey soils with clayey sandy mud, often blocked as of surface.

d) Principal Constraints

Upstream: Sometimes reduced depth. Texture sometimes sandy. In-depth clogging. Sometimes high slope.

Downstream: Texture sometimes sandy .Semi-permanent clogging

e) Relative Value of the unit

Upstream:

Agricultural value limited to the cultures tolerating clogging, in particular the legume and rice growing. These aptitudes are a primarily function of texture, useful depth of the soil, the pierrosity of surface, the depth level of the level of permanent clogging, etc. Consequently:

Item	Evaluation
Mechanization	good with poor
Traditional agriculture	good with passable
Perennial culture	passable with rather good
Forestry	passable with rather good
Breeding	enough good with passable

Downstream:

Idem with the upstream part except for the slope which is generally weak and the absence of the pierrosity for surface. But here the aptitude is also a function of total porosity and the speed of infiltration. Consequently:

Item	Evaluation
Mechanization	good with poor
Traditional agriculture	good with passable
Perennial culture	poor
Forestry	poor
Breeding	passable

(5) Data Resulted from Physicochemical Analysis by Cartographic Unit

From U.C 18 and U.C 19, the dominant soils are the altered renovated ferrallitic soils and the renovated altered ferrallitic soils. They are characterized by:

- a clay rate higher than 30 %, even in the horizons of surface;
- a water content useful varying from 7,0 to 12,0;
- a pH water generally acid and ranging between 4,8 and 5,8;
- a pH Kcl ranging between 3,8 and 4,8;
- a ratio C/N which varies from 9,0 to 13,4 in the first three horizons of the profile;
- a cation capacity of exchange which lies between 4,90 and 13,92 while the sum of the bases varies from 1,76 to 11,48;
- an electric conductivity of extracts oscillating enters 22 and 120 but stabilizing themselves around 20 - 30.

Concurrently to these dominant soils, one finds soils ferrallitic altered colluvionnés hardened or hydromorphic located downstream from these units in particular downstream from S 18 and S 19. They give the following results:

- the clay rate is generally lower than 20 % in the surface horizons (0 - 15 cm) lies between 25 and 30 % in the subjacent horizons (15 - 60 cm);
- the water content useful lies between 4,2 and 8;
- the always acid pH varies from 4,5 to 5,3;

- the ratio C/N lies between 8,1 and 12,1;
- the cation capacity of exchange lies between 2,72 and 5,98, and summons it bases between 0,82 and 2,04;
- the electric conductivity of extracts varies from 14 to 34 but is generally close to 30.

For U.C 26 and U.C 26a, the dominant soils are the modal altered ferrallitic soils and the renovated altered ferrallitic soils. The analyzed profiles give the following results:

- the clay rate is higher than 45 % as of surface and is accentuated towards the depth;
- the water content is around 10 (10,1 to 13);
- the pH water lies between 4,5 and 5,3 and the pH Kcl between 3,5 and 3,8;
- the ratio C/N varies from 7,5 to 12,1 but is generally around 11 - 12;
- the capacity of exchange lies between 2,88 and 6,08 and summons it bases between 1,28 and 2,88;
- the electric conductivity of extracts varies from 28 to 48.

In the same cartographic unit one finds altered ferrallitic modal soils with facies hardened and altered soils ferrallitic hardened and hardened altered soils ferrallitic whose profile was analyzed. The results are:

- the clay rate passes from 22 on the surface to 27,5 in-depth;
- the water content useful is relatively low and passes from 3,6 on the surface with 5,9 in-depth;
- the pH water is stabilized around 5 and the pH Kcl around 4
- the ratio C/N varies from 11,4 on the surface with 8,2 in-depth;
- the capacity of exchange passes from 5,90 on the surface and 4,16in-depth, while the sum of the bases decreases with the depth (4,04 to1,54);
- the electric conductivity of extracts varies from 50 on the surface to 13 in-depth.

For U.C 27, U.C 27 and U.C 27c/a, the dominant soils are the altered soils colluvionnés modal, hardened or hydromorphic or altered colluvionnés modal with renovated facies. Two profiles were analyzed and give the results according to:

- the clay rate is higher than 80 % as of surface;
- the water content useful lies between 7,4 and 13,4;
- the pH water lies between 4,6 and 5,2 and the pH Kcl between 3,8 and 4,0;
- the ratio C/N varies from 8,7 to 12,3;
- the capacity of exchange lies between 3,84 and 7,86 while the sum of the bases varies from 1,46 to 2,94;
- the electric conductivity of extracts varies from 20 to 70 but the average is around 20

For U.C 22 (alluvial plain and large lowlands), only one profile was analyzed and relates to the hydromorphic soils not very humus-bearing with pseudo-gley of surface (dominant soils of the U.C). It gives the following results:

- the clay rate passes from 30 % on the surface to 60 % in-depth;

- the water content useful varies from 12,9 to 19;
- the pH water lies between 4,6 and 5,3 and the pH Kcl between 3,5 and 3,7;
- report/ratio C/N varies from 11,5 in-depth to 7,8 in-depth;
- the capacity of exchange is 12,0 on the surface and 3,5 in-depth;
- the sum of the bases passes from 2,80 on the surface to 1,22 in-depth;
- the electric conductivity of extracts is 58 on the surface and 28 in-depth.

For U.C g, only one profile was taken and analyzed but the dominant soils it does not represent is a not very humus-bearing hydromorphic soil with pseudo-gley of surface (profile N° 300 m of the track S 6). The results are the following:

- the clay rate decreases towards the depth, it passes from 32,5 to 25,0;
- the water content useful passes from 7,7 on the surface to 6,6 towards the depth;
- the pH water is around 5, the pH Kcl of 3,7;
- the ratio C/N is 11,9 on the surface and 7,5 towards the depth;
- the capacity of exchange passes from 5,60 on the surface to 2,88 in-depth;
- the sum of the bases from 2,88 to 1,76;
- the electric conductivity of extracts passes from 34 to 20

For U.C s, the dominant soils are the not very humus-bearing hydromorphic soils with pseudo-gley of surface whose profile was analyzed (profile N° 200 m of the track S 4bis). They give the following results:

- the clay rate is higher than 40 % since the sirface;
- the water content useful passes from 12,7 on the surface to 14,3 in-depth;
- the pH water varies between 4,6 and 5,3 and the pH Kcl between 3,5 and 3,7;
- the ratio C/N is 11,5 on the surface and 8,0 in-depth;
- the capacity of exchange passes from 12,0 to 3,52;
- the sum of the base passes from 2,80 to 1,22;
- the electric conductivity of extracts varies from 28 to 58.

(6) Conclusions and Recommendations

The morpho-pedological study with the 1/50.000 scale of the area called " Plain of San-Pédro " made it possible to highlight 11 cartographic units for which one can make the following remarks:

- For U.C 18, U.C 19 and U.C 27c, the very sharp slope is the most important limitation in particular regard to mechanization. These cartographic units must be let to remain under natural vegetable cover, to be occupied preferentially by perennial cultures for ensuring an effective protection against soil erosion; that supposes a manual clearing at the time of very development and the setting-up of effective anti-erosive systems.
- For U.C.26a and 27c/a the outcrops of rocks are also restrictive for mechanization. There the implementation of manual works is advised;
- Fore U.C 26 and U.C the 27 constraints are generally negligible. However the surfaces are partly reduced. These cartographic units are adapted to any system and

any type of culture;

- For U.C 20 constraints are limited to the reduced depth and clogging localized places. These zones are traditionally reserved for the food crops and the annual cultures. They can also be cultivated out of rainfed rice. They are favorable with mechanization. Here also the surfaces are not very important;
- For U.C 22, U.C S and U.C G, the agronomic values are a primarily function of texture (it should not be too sandy or too clayey), of total porosity, the speed of infiltration of water in the soil, of the values of pH U.C 22 and U.Cs conceal potentialities more importan than U.C g but a more perfect knowledge of these potentialities requires more etailed pedological studies;

Ultimately, all the described cartographic units make it possible to affirm that the study zone conceals great cultivable soil potentialities, in particular for the perennial cultures and irrigated rice growing on lowlands. Moreover the slopes and tops of high collines, low hills and convex planed hilly lands in plan convex are occupied by cocoa and coffee fields which extend sometimes to the plain. The lowlands are often used for rice cultivation.

However, for the reasons mentioned above and for the control of development, one should not stop with this study at 1/50.000 scale but more detailed studies (pedological study with the 1/10,000 scale for the "up-lands" and with the 1/5,000 scale or 1/2.000 scale for the lowlands and the alluvial plains), from which the farming systems and farming methods could thus be determined with a higher exactitude.

(7) Results of the Physicochemical Analyses of Samples

(a) Station 1
Localization: Alluvial plain
Typology of the soil: not very humus-bearing hydromorphic soil with pseudo-gley.

Horizon (cm)	Granulometrie (% of weight dried with the air)					Acidity		Caracterystiques Hydrodynamics			
	Clay Silt	Fine Silt	arge S and	Fine Sand	Coarse Sand	PH Water	pH Kcl	PF 2,5	PF 4,2	Water	useful C.E.E
00-30	65,0	15,0	14,2	3,3	2,5	4,5	3,4	55,8	29,5	26,3	120
30-50	72,5	15,0	6,0	3,8	2,7	4,4	3,2	50,1	28,9	21,2	120
50-70	60,0	15,0	3,5	14,0	7,5	4,4	3,2	49,0	30,5	18,5	120

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complex Absorbent		
	M.O (%)	C (%)	N (‰)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00-30	3,92	2,28	1,62	14,1	14,7	481	0,92	0,60	0,12	0,62	13,12	2,26	17,2
30-50	1,89	1,10	0,87	12,6	9,4	284	0,64	0,60	0,08	0,62	12,78	1,94	15,2
50-70	1,79	1,04	0,92	11,3	6,0	275	0,46	0,30	0,06	0,46	13,12	1,28	9,8

(b) Station 2
Localization: Alluvial plain
Typology of the soil: not very humus-bearing hydromorphic soil with pseudo-gley

Horizon (cm)	Granulometrie (% of weight dried with the air)					Acidity		Caracterystiques Hydrodynamics			
	Clay Silt	Fine Silt	Large. Sand	Fine Sand	Coarse Sand	PH Water	pH Kcl	PF 2,5	PF 4,2	Water	useful C.E.E
00 – 30	30,0	10,0	25,9	22,5	11,6	5,3	4,0	24,0	11,5	12,5	26
30 – 50	35,0	7,5	3,2	33,0	21,3	5,3	4,0	26,5	13,3	13,2	32
50 – 70	37,5	10,0	3,0	31,9	17,6	5,4	3,9	29,5	14,2	15,3	28

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complex Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 30	1,41	0,82	0,73	11,2	9,4	110	1,44	0,58	0,06	0,36	4,30	2,44	56,7
30 – 50	0,72	0,42	0,53	7,9	6,2	82	0,58	0,32	0,04	0,26	4,68	1,20	25,6
50 – 70	0,34	0,20	0,48	4,2	6,8	128	0,46	0,54	0,04	0,22	4,32	1,26	29,2

(c) Station 3
Localization: Lower slope (2 - 5 %)
Typology of the soil: modal colluvionné altered ferrallitic soil

Horizon (cm)	Granulometrie (% of weight dried with the air)					Acidity		Caracterystiques Hydrodynamics			
	Clay Silt	Fine Silt	Large. Sand	Fine Sand	Coarse Sand	PH Water	pH Kcl	PF 2,5	PF 4,2	Available Water	C.E.E
00-14	25,0	5,0	4,8	17,2	48,0	5,4	4,7	15,9	9,0	6,9	38
14-30	30,0	5,0	3,3	17,8	43,9	5,4	4,1	18,9	10,4	8,5	20
30-77	32,5	5,0	3,8	14,3	44,4	5,3	4,0	17,1	10,7	6,4	24

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complex Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00-14	2,48	1,44	1,37	10,5	7,8	234	3,24	0,98	0,18	0,08	7,94	4,48	56,4
14-30	1,17	0,68	0,81	8,4	6,4	147	1,24	0,60	0,10	0,08	4,64	2,02	43,5
30-77	0,79	0,46	0,62	7,4	1,5	133	1,04	0,40	0,10	0,06	3,74	1,60	42,8

Measure density
Apparent density: 00 - 14: 1,7
14 - 30: 1,7
30 - 77: 1,8

(d) Station 4
Localization: Alluvial plain
Typology of the soil: not very humus-bearing hydromorphic soil with pseudo-gley

Horizon (cm)	Granulometrie (% of weight dried with the air)					Acidity		Caracterystiques Hydrodynamics			
	Clay Silt	Fine Silt	Large. Sand	Fine Sand	Coarse Sand	PH Water	pH Kcl	PF 2,5	PF 4,2	Available Water	C.E.E
00-30	42,5	7,5	7,3	16,2	26,5	5,3	3,9	26,7	15,7	11,0	22
30-50	45,0	10,0	6,5	16,7	21,8	5,1	3,7	28,8	17,5	11,3	26
50-70	47,5	10,0	5,1	20,8	16,6	5,0	3,7	35,4	23,2	12,2	18

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complex Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00-30	1,55	0,90	0,90	10,0	2.0	73	1,24	0,60	0,14	0,08	5,16	2,06	39,9
30-50	0,86	0,50	0,61	7,8	1.4	60	0,68	0,28	0,08	0,10	4,68	1,14	24,4
50-70	0,69	0,40	0,59	6,8	-	82	0,52	0,14	0,06	0,06	4,02	0,78	19,4

(e) Station 5
Localization: Lowland
Typology of the soil: not very humus-bearing hydromorphic soil with pseudo-gley

Horizon (cm)	Granulometric (% of weight dried with the air)					Acidity		Caracterystiques Hydrodynamics			
	Clay Silt	Fine Silt	Large. Sand	Fine Sand	Coarse Sand	PH Water	pH Kcl	PF 2,5	PF 4,2	Available Water	C.E.E
00-30	62,5	15,0	10,9	5,8	5,8	5,0	3,7	54,1	29,2	4,9	46
30-50	67,5	17,5	6,7	5,5	2,8	5,2	3,7	48,5	29,9	18,6	28
50-70	60,0	20,0	7,6	6,9	5,5	5,2	3,8	41,6	25,6	16,0	29

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complex Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00-30	6,04	3,51	2,32	15,1	9,2	344	1,86	0,70	0,16	0,18	19,10	2,90	15,2
30-50	1,31	0,76	0,90	8,4	6,0	234	1,28	0,76	0,06	0,14	9,76	2,24	23,0
50-70	0,69	0,40	0,62	6,5	1,9	215	1,24	1,30	0,08	0,18	8,10	1,80	22,2

(8) Description of the Profiles Sampled and Analysed within the Framework of Study Realized by BNETD

SHEET OF DESCRIPTION N° 1

Profile N°: 200 m of the Track S4bis
Vegetation: gallery-forest
Physiography - form: Lowland
Slope: 0 - 2 %
Typology: not very humus-bearing hydromorphic soil with resting pseudo-gley of surface on a not very advanced soil of hydromorphic contribution: colluvial: 78/28

Description

0 - 16: " Dark grayish brown " into wet (10 YR 4/2), argillaceous, not gravillonnaire, polyhedric subangulaire, very porous, not very compact structure with, very many very fine, fine, average and coarse roots

16 - 49: " Grayish brown " into wet (10 YR 5/2), argillaceous, not gravillonnaire, strtucture polyhedric subangulaire, porous, compact, many fine, very fine and average roots

49 - 112: " Light brownish grey " " into wet (10 YR 6/2) with spots brown yellowish (10 YR 5/6), argilo-sandy, not gravillonnaire,

structure polyhedric angular, not very porous, compact, many fine roots and very fines.

112 - 150: " White " (10 YR 8/2) with spots " yellowish brown " (10 YR 5/6), sandy little gravillonnaire (0 - 15 % of fine gravels, quartz gravels and stones, structure polyhedric angular, not very porous, movable, very few very fine roots.

Results of the physicochemical analyses

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00-16	55,0	7,5	5,8	10,9	20,8	4,6	3,5	38,3	25,6	12,7	58
16-49	47,5	5,0	4,2	18,0	25,3	5,0	3,7	34,6	20,0	14,6	30
49-80	42,5	7,5	4,9	15,5	29,6	5,3	3,7	34,6	20,3	14,3	28

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00-16	4,16	2,42	2,10	11,5	5,4	206	1,52	0,92	0,16	0,20	12,0	2,80	23,3
16-49	1,17	0,68	0,87	7,8	1,8	110	0,72	0,64	0,06	0,14	5,96	1,56	26,2
49-80	0,96	0,56	0,70	8,0	1,8	321	0,32	0,32	0,04	0,14	3,52	1,22	34,7

SHEET OF DESCRIPTION No. 2

Profile No.: 0 - 2 % with the foot of an elevation with rather strong slope (10 %)

Typology of the soil: 500 m track S 4bis

Vegetation: Forest gallery with very dense underwood

Physiography - form: Alluvial plain

Slope: Not very humus-bearing hydromorphic soil with pseudogley of surface (7.8)

Description

0 -18: "Yellowish brown " into wet (10 YR 5/4), argilo-limono-sandy, not gravillonnaire, structure polyhedric subangulaire, very porous, not very compact, many average roots, fines and very fines.

18 - 35: Light yellowish brown " wet (10 YR 6/4) with spots brown " yellowish brown " (10 YR 5/6), argilo-muddy, not gravillonnaire, structure polyhedric subangulaire, porous, compact, many fine roots and very fines.

35 - 60: "Light yellowish brown " into wet (10 YR 6/2) with spots brtun yellowish (10 YR 5/6), argilo-muddy with argillaceous, not gravillonnaire, structure polyhedric angular, porous, compact, very few very fine and fine roots.

60 - 99: "Gray Light " (10 YR 7/2) with spots " yellowish brown " (10 YR 5/6), argilo-muddy with argillaceous, not gravillonnaire, not very porous, compact, very few very fine roots.

99 -150: " Light Gray) into wet (10 YR 7/1) with spots " yellowish brown " (10 YR 5/6), argilo-muddy, not gravillonnaire, polyhedric structure subangulaire, very few fine roots.

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 - 18	35,0	15,0	4,2	13,3	32,5	4,9	3,6	31,6	18,7	12,9	36
18 - 35	47,5	15,0	4,0	11,6	21,9	5,0	3,5	37,0	21,0	16,0	20
35 - 60	60,0	20,0	5,2	4,3	10,5	5,1	3,5	47,5	28,1	19,0	19

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 - 18	3,22	1,87	1,51	12,1	5,1	215	1,88	0,86	0,18	0,08	8,0	3,0	37,5
18 - 35	1,14	0,66	0,87	7,6	1,8	105	0,88	0,38	0,08	0,08	7,30	1,42	19,5
35 - 60	0,86	0,50	0,76	6,6	1,8	110	0,64	0,41	0,06	0,10	8,46	1,24	14,7

SHEET OF DESCRIPTION No. 3

Profile No: 800 m of the track S 4bis
Vegetation: Developed Reeru
Physiography - form: Average terrace
Slope: 6 %
Typology of the soil: Modal colluvionn* altered ferrallitic soil with renovated facies

Description

0 -18: " Brown " into wet (10 YR 4/3), sablo-argillaceous, very little gravillonnaire (0 - 5 % of ferruginous and quartzose fine gravels), structure polyhedric subangulaire, very porous, not very compact, very many fine, average roots and very fines.

18 - 37: " Dark brown " into wet (7,5 YR 3/4), argilo-sandy, gravillonnaire (50 - 70 % of ferruginous and quartzose fine gravels), structure polyhedric subangulaire, porous, compact, many fine roots and very fines.

37 - 65: " Strong brown " into wet (7,5 YR 4/6) argilo-sandy, gravillonnaire (50 - 70 % of ferruginous fine gravels and quartz rollers, structure polyhedric angular, porous, compact, many fine roots and very fines.

65 - 95: " Strong brown " into wet (7,5 YR 5/6), argilo-sandy, gravillonnaire (50 - 70 % of ferruginous fine gravels and quartz rollers), structure polyhedric angular, not very porous, compact, very few fine roots.

95 -120: "Strong brown" into wet (7,5 YR 5/8), argilo-limono-sandy, fairly gravillonnaire (30 - 50 % of ferruginous fine gravels and quartz rollers with remains of deterioration of the rock-mother), structure polyhedric angular, not very porous, compact, very few fine roots.

120 - 150: "Strong brown" into wet (7,5 YR 5/8), argilo-sablo-muddy, little gravillonnaire (15 - 30 % of ferruginous and quartzose fine gravels with remains of rocks).

Physicochemical results of analyses

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 18	25,0	2,5	4,0	25,5	43,0	4,8	3,9	15,0	9,1	5,9	36
18 – 35	32,5	2,5	3,1	15,6	46,0	5,1	3,9	17,6	11,9	5,7	22
35 - 65	37,5	5,0	34,6	9.9	43,0	5,1	3,9	25,2	4,0	11,2	20

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Total	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 18	2,17	1,26	1,18	10,7	9,0	147	0,52	0,18	0,02	0,04	2,88	0,76	26,4
18 – 35	1,31	1,76	0,87	8,7	1,8	115	0,84	0,26	0,04	0,06	2,72	0,20	44,1
35 - 65	1,17	0,68	0,84	8,1	-	215	0,61	0,32	0,04	0,06	2,24	1,06	47,3

SHEET OF DESCRIPTION No. 4

Profile No.: 100 m of the track S6
Vegetation: Developed Recru
Physiography - form: Slope or higher slope (U.C 27c)
Slope: 25 - 30 %
Typology of the soil: Renovated altered ferrallitic soil (6.15)

Description

0 - 13: " Reddish brown " into wet (5 YR 4/3), argilo-sandy with argillaceous, little gravillonnaire (0 - 5 % of fine gravels ferrugineux)n structure polyhedric subangulaire, very porous, movable, many very fine roots, fine, average and coarse

13 - 31: " Reddish brown " into wet (5 YR 4/4), argillaceous, fairly gravillonnaire (15 - 30 %) of ferruginous fine gravels), structure polyhedric subangulaire, porous, not very compact, many fine, very fine and average roots.

31 - 54: " Yellowish red " into wet (5 YR 5/6), argillaceous, fairly gravillonnaire (15 - 30 % of ferruginous fine gravels), structure polyhedric subangulaire, porous, not very

compact, many fine, very fine and average roots.

51 - 86: " Yellowish red " into wet (5 YR 5/8), argilo-muddy, little gravillonnaires (5 - 15 % of ferruginous and quartzose fine gravels), structure polyhedric angular, porous, compact, very few very fine and fine roots

86 - 145: " Yellowish red " into wet (5 YR 5/8), argilo-muddy, little gravillonnaires (5 - 15 % of ferruginous and quartzose fine gravels with remains of deterioration of the rock-mother), structure polyhedric angular, not very porous, compact, rare very fine roots.

Results of the physicochemical analyses

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 13	47,5	7,5	4,2	24,1	26,7	4,5	3,6	28,7	18,6	10,1	48
13 – 31	50,0	7,5	4,5	12,3	25,7	4,6	3,5	31,9	19,8	12,1	32
31 - 51	55,0	2,5	7,2	7,4	27,9	4,7	3,6	32,8	21,7	11,1	28

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Total	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 13	3,20	1,86	1,54	12,1	11,3	224	1,11	0,64	0,10	0,08	6,08	2,26	37,2
13 – 31	2,10	1,22	1,12	10,9	2,6	275	0,06	0,68	0,08	0,08	4,96	1,90	38,3
31 - 51	1,65	0,96	1,01	9,5	1,8	96	0,66	0,48	0,06	0,08	3,46	1,28	37,0

SHEET OF DESCRIPTION No. 5

Profile No.: 200 m of the track S 6
Vegetation: Developed Recru (forest)
Physiography - form: Average slope
Slope: 5 - 8 %
Typology of the soil: Hardened colluvionn* ferrallitic soil (6.22 IV)

Description

0 - 13: " Brown " into wet (7,5 YR 4/4), sablo-argillaceous, very little gravillonnaire (0 - 5 % of ferruginous and quartzose fine gravels), structure polyhedric subangulaire, very porous, movable, very many average and fine roots.

13 - 29: " Strong brown " into wet (7,5 YR 4/6), sablo-argillaceous, few gravillonnaire (15 - 30 %) ferruginous and quartzose fine gravels), structure polyhedric subangulaire, very porous, not very compact, very many average and fine roots.

29 - 49: " Strong brown " into wet (7,5 YR 4/6), argilo-sandy, fairly gravillonnaire (30 - 50 % of ferruginous and quartzose fine gravels), polyhedric subangulaire, not very compact structure porous, many fine roots and very fines.

49 - 66: " Strong brown " into wet (7,5 YR 5/6), argilo-sandy with argillaceous, fairly gravillonnaires (30 - 50 %) of ferruginous and quartzose fine gravels), structure polyhedric subangulaire, porous, compact, many very fine and fine roots

66 - 88: " Strong brown " into wet (7,5 YR 5/8), argilo-muddy, fairly gravillonnaires (30 - 50 % of ferruginous and quartzose fine gravels), structure polyhedric angular, not very porous, very compact, very few fine roots.

88 and +: Carapace dug

Results of the physicochemical analyses

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2.5	pF 4.2	Available Water	C.E.E
00 – 13	22,5	5,0	6,0	17,8	48,7	4,5	3,7	16,0	9,3	6,7	21
13 - 29	25,0	5,0	4,9	10,8	51,3	4,8	3,8	18,8	10,8	8,0	22
29 - 49	27,5	2,5	4,4	14,3	51,3	4,9	3,9	17,9	11,0	6,9	20

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (‰)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 13	1,31	0,76	0,87	8,7	6,8	133	0,68	0,22	0,06	0,06	3,20	1,02	31,9
13 - 29	0,89	0,52	0,64	8,1	1,8	119	0,52	0,28	0,06	0,06	3,04	0,92	30,3
29 - 49	0,96	0,56	0,59	9,5	2,2	128	0,46	0,24	0,06	0,06	2,72	0,82	30,2

SHEET OF DESCRIPTION No. 6

Profile No.: 300 m of the track S 6
Vegetation: Old fallow
Physiography - form: Lower slope
Slope: 2 - 5 %
Typology of the soil: Not very humus-bearing hydromorphic soil with pseudo-gley of surface (7.8)

Description

0 - 15: " Dark grayish brown " into wet (10 YR 4/2), argilo-sandy, not gravillonnaire, polyhedric subangulaire, porous structure, piece of furniture, many fine and average roots.

15 - 33: " Grayish brown " into wet (10 YR 5/2), argilo-limono-sandy, not gravillonnaire, structure polyhedric subangulaire, not very porous, not very compact, many fines root, very fine and average.

33 - 65: " Gray gold Gray light " into wet (10 YR 6/1), argilo-limono-sandy, moy very little gravillonnaire (0 - 5 % of quartz fine gravels), structure polyhedric angular, not very porous, not very compact, very few fine roots and very fines.

65 - 95: " Light brownish Gray " into wet (2,5 Y 6/2), argilo-limono-sandy, few gravillonnaire (15 - 30 %) quartz fine gravels), structure polyhedric angular, not very porous, compact, very few very fine and fine roots

95 - 135: " Gray Light " into wet (5 Y 7/2), argilo-muddy, little gravillonnaires (5 - 15 % of quartz fine gravels), structure polyhedric angular, not very porous, compact, very few very fine roots.

Results of the physicochemical analyses

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 15	32,5	7,5	13,9	10,5	35,6	4,9	3,8	22,5	14,8	7,7	34
15 – 33	27,5	7,5	8,7	16,0	40,3	5,3	3,6	21,1	12,8	8,3	20
33 - 65	25,0	7,5	3,6	13,7	50,2	5,3	3,7	16,4	9,8	6,6	20

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 15	3,03	1,76	1,48	11,9	9,3	188	1,68	0,92	0,16	0,12	5,60	2,88	51,4
15 – 33	1,38	0,86	0,76	11,3	3,4	96	1,08	0,74	0,08	0,16	4,64	2,06	44,4
33 - 65	0,69	0,40	0,53	7,5	-	60	0,66	0,86	0,06	0,18	2,88	1,76	61,1

SHEET OF DESCRIPTION No. 7

Profile No.: 00 m of the track S 6bis
Vegetation: Developed Recru (forest)
Physiography - form: Summit of interfluve
Slope: 0 - 2 %
Typology of the soil: Renovated altered ferrallitic soil(6.18)

Description

0 - 15: " Yellow brown " into wet (5 YR 4/6), argillaceous, little gravillonnaire (5 - 15 % of ferruginous, quartzose fine gravels and quartz stones), structure polyhedric subangulaire, very porous, movable, very many fine, very fine and average roots.

15 - 45: " Yellow brown " into wet (5 YR 5/6), fairly argillaceous gravillonnaire (15 - 30 %) of ferruginous, quartzose fine gravels and quartz stones), structure polyhedric subangulaire, porous, not very compact, many very fine and fine roots.

45 - 70: " Yellow brown " into wet (5 YR 5/8), argilo-muddy, little gravillonnaire (0 - 15 % of ferruginous, quartzose fine gravels and of quartz gravels)), structure polyhedric angular, not very compact, not very porous, many very fine roots.

70 - 100: " Yellow brown " into wet (5 YR 5/8), argilo-muddy, sandy, little gravillonnaire, (0 - 15 % of ferruginous and quartzose fine gravels), structure polyhedric angular, not very porous, not very compact, not of roots.

100 - 150: " Reddish yellow " into wet (5 YR 6/8), argilo-sandy, not gravillonnaires (0 - 15 % of ferruginous and quartzose fine gravels), structure polyhedric angular, not very porous, not very compact, not of roots.

Planimetric results

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 15	57,5	7,5	7,5	7,5	20,0	4,9	3,8	32,1	21,5	10,6	37
15 – 33	65,0	10,0	6,2	5,9	12,9	5,3	3,6	38,3	25,3	13,0	28
33 - 65	62,5	7,5	6,1	7,5	16,4	5,3	3,7	34,6	22,4	12,2	34

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca''	Mg''	K'	Na'	T (C.E)	S	V (S/T)
00 – 15	3,03	1,76	1,48	11,9	13,6	1,88	1,68	0,92	0,16	0,12	5,60	2,88	51,4
15 – 33	1,48	0,86	0,76	11,3	7,4	96	1,08	0,74	0,08	0,16	4,64	2,06	44,4
33 - 65	0,69	0,40	0,53	7,5	7,8	60	0,66	0,86	0,06	0,18	2,88	1,76	61,1

SHEET OF DESCRIPTION No. 8

Profile No.: 900 m of the track 6bis
Vegetation: Old fallow and annual culture
Physiography - form: Average slope (slope)
Slope: 10 - 15 %
Typology of the soil: Modal colluvionn* altered ferrallitic soil with renovated facies.

Description

0 - 25: "Brown" into wet (7,5 YR 4/4), argilo-sandy, not gravillonnaire, structure polyhedric subangulaire, very porous, movable, many fine, average roots and very fines.

25 - 55: "Strong brown" into wet (7,5 YR 4/6), argilo-sandy not gravillonnaire structure polyhedric subangulaire, porous, not very compact, very few fine roots and very fines.

55 - 90: "Strong brown" into wet (7,5 YR 4/6), argilo-sandy, little gravillonnaire (15 - 30 % of ferruginous, quartzose fine gravels and quartz stones), structure polyhedric angular, not very porous, not very compact, very few very fine roots.

90 - 120: "Strong brown" into wet (7,5 YR 5/6), argilo-limono-sandy, not gravillonnaire, structure polyhedric angular, not very porous, not very compact, not of roots.

120 - 150: Strong brown wet (7,5 YR 5/8), argilo-muddy, not gravillonnaires, some remains of deteriorated rock, structure polyhedric angular, not very porous, not very compact, not of roots

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 25	30,0	2,5	6,6	18,2	42,7	4,8	4,0	17,4	9,4	8,0	72
25 – 55	35,0	2,5	5,5	18,8	38,2	5,1	4,0	20,4	11,0	9,4	34
55 - 90	35,0	5,0	5,3	12,7	42,0	5,2	3,9	22,2	13,8	8,4	22

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 25	2,55	1,48	1,20	12,3	6,8	82	1,66	0,94	0,18	0,16	3,84	2,94	76,6
25 – 55	1,11	0,82	0,81	10,1	-	64	1,08	0,88	0,08	0,12	4,64	2,16	46,6
55 - 90	1,31	0,76	0,87	8,7	-	62	1,84	0,76	0,08	0,14	3,84	1,82	47,4

SHEET OF DESCRIPTION NO. 9

Profile No.: 200 m of the track S 9 North
Vegetation: Perennial culture (cocoa)
Physiography - form: Average slope (V 19)
Slope: 3 - 8 %
Typology of the soil: Modal colluvionn* altered ferrallitic soil with hydromorphic facies

Description

0 - 17: " Dark brown " into wet (7,5 YR 3/2), sablo-argillaceous, not gravillonnaire, structure polyhedric subangulaire, porous, not very compact, very many fine, average roots and very fines.

17 - 50: " Strong brown " into wet (7,5 YR 4/6), sablo-argillaceous not gravillonnair porous, not very compact with compact, many fine roots and very fines.

50 - 92: " Strong brown into wet (7,5 YR 5/6), sablo-argillaceous with argilo-sandy, not gravillonnaire, structure polyhedric angular, not very porous, compact, very few fine roots.

92 - 148: " Strong brown " into wet (7,5 YR 5/8), argilo-sandy, not gravillonnaire, structure polyhedric angular, not very porous, compact, not of roots.

100 - 150: Reddish yellow into wet (5 YR 6/8), argilo-sandy, not gravillonnaires (0 - 15 % of ferruginous and quartzose fine gravels), structure polyhedric angular, not very porous, not very compact, no roots.

Physicochemical results

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 17	20,0	5,0	4,5	23,8	46,7	5,3	4,1	16,6	10,0	6,4	16
17 – 50	25,0	5,0	4,6	18,4	47,0	5,2	4,1	17,0	11,1	5,9	18
50 - 80	27,5	5,0	5,3	12,0	50,2	5,3	4,1	19,7	12,7	7,0	14

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 17	1,62	0,94	0,92	10,2	3,6	110	1,42	0,52	0,04	0,06	5,98	2,04	34,1
17 – 50	0,89	0,52	0,56	9,3	4,2	101	0,92	0,26	0,02	0,04	3,54	1,24	35,0
50 - 80	0,79	0,46	0,56	8,2	1,7	101	0,64	0,38	0,02	0,08	3,90	1,12	28,7

SHEET OF DESCRIPTION NO. 10

Profile No.: 300 m of the track S 9 North
Vegetation: Old fallow
Physiography - form: Average slope (V 19)
Slope: 5 - 8 %
Typology of the soil: Altered renovated ferrallitic soil(6.18).

Description

0 - 18: " Dark reddish brown " into wet (5 YR 3/2), argilo-sandy little gravillonnaire, (05 - 15 % of ferruginous, quartzose fine gravels and quartz stones), structure polyhedric subangulaire, porous, not very compact, many fine, very fine and average roots.

18 - 43: " Yellowish red " into wet (5 YR 4/6), fairly argilo-sandy gravillonnaire (15 - 30 % of ferruginous, quartzose fine gravels and quartz stones), structure polyhedric subangulaire, porous, compact, many fine roots and very fines.

43 - 75: " Yellowish red " into wet (7,5 YR 5/6), argilo-sandy, little gravillonnaire (05 - 15 % of fine gravels ferruginous, quartzose, quartz stones and remains of faded rock), structure polyhedric angular, porous, compact, very few very fine roots.

75 - 150: Rock-mother in deterioration.

Physicochemical results

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 18	32,5	10,0	5,9	15,0	36,6	5,4	4,8	24,3	16,7	7,6	100
18 – 43	30,0	5,5	6,6	11,0	44,0	5,8	4,7	24,9	17,1	7,8	33
43 - 75	37,5	7,5	6,4	7,0	41,6	5,6	4,4	32,3	21,3	11,0	28

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (‰)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 18	6,11	3,55	2,65	13,4	12,4	298	7,64	3,44	0,32	0,08	13,92	11,48	82,5
18 – 43	1,82	1,06	1,01	10,5	3,4	133	1,66	1,38	0,12	0,14	7,40	3,30	44,6
43 - 75	1,14	0,66	0,73	9,0	-	115	1,24	1,20	0,12	0,18	5,76	2,74	47,6

SHEET OF DESCRIPTION NO. 11

Profile No.: 500 m of the track S 9 North
Vegetation: Fairly developed Recru
Physiography - form: Summit of interfluve
Slope: 2 - 5 %
Typology of the soil: Altered renovated ferrallitic soil(6.18).

Description

0 - 18: " Dark reddish brown " into wet (5 YR 3/2), argillaceous very little

gravillonnaire, (0 - 5 % of ferruginous and quartzose fine gravels, structure polyhedric subangulaire, very porous, not very compact, many fine, coarse and average roots.

18 - 39: " Reddish brown " into wet (5 YR 4/4), argillaceous, few gravillonnaire (5 - 15 % ferruginous and quartzose fine gravels, structure polyhedric subangulaire, porous, not very compact, very few very fine roots.

39 - 65: " Yellowish red " into wet (7,5 YR 4/6), argillaceous, not gravillonnaire, structure polyhedric angular, porous, compact, very few very fine roots.

65 - 110: " Yellowish red " into wet (5 YR 5/6), argilo-limono-sandy, not gravillonnaire, remains of deteriorated rock, not very porous, compact, very few very fine roots.

Physicochemical results

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 15	50,0	7,5	5,5	12,9	24,1	5,2	4,8	29,2	21,6	7,6	120
15 – 39	55,0	7,5	3,3	6,2	28,0	5,0	4,1	30,0	20,6	9,4	58
39 - 65	67,5	10,0	3,7	5,2	13,6	4,8	4,0	38,9	26,9	12,0	64

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (‰)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 15	5,83	3,39	2,83	12,0	15,7	334	7,62	1,98	0,68	0,16	13,76	10,44	75,9
15 – 39	2,03	1,18	1,22	9,7	2,8	188	2,14	0,88	0,24	0,10	10,02	3,36	33,5
39 - 65	1,69	0,98	0,95	10,3	2,8	174	1,26	1,08	0,10	0,10	10,06	2,54	25,3

SHEET OF DESCRIPTION NO. 12

Profile No.: 800 m of the track S 10
Vegetation: Perennial cultures (coffee and cocoa)
Physiography - form: Average slope (V 19)
Slope: > 10 %
Typology of the soil: Altered renovated ferrallitic soil

Description

00 - 14: " Dark reddish brown " into wet (5 YR 3/4), argilo-sandy very little gravillonnaire, (0 - 5 % of ferruginous and quartzose fine gravels, structure polyhedric subangulaire, very porous, compact, many very fine, fine, coarse and average roots.

14 - 34: " Reddish brown " into wet (5 YR 4/4), argillaceous, fairly gravillonnaire (15 - 30 % of ferruginous and quartzose fine gravels, structure polyhedric subangulaire, porous, compact, very few very fine, fine and average roots.

34 - 53: " Yellowish red " into wet (7,5 YR 4/6), argillaceous, gravillonnaire (30 - 50 % of ferruginous, quartzose fine gravels and quartz gravels), structure polyhedric subangulaire, porous, compact, very few very fine and fine roots.

53 - 86: " Yellowish red " into wet (5 YR 5/6), argilo-muddy, few gravillonnaire (5 - 15 % fine gravels ferruginous and quartzose, gravels and stones of quartz, remains of deteriorated rock, porous, compact, very few very fine and fine roots.

86 - 145: Faded rock.

Physicochemical results

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 14	37,5	5,0	3,3	20,0	34,2	4,8	3,8	21,8	14,0	7,8	32
14 – 34	40,0	5,0	1,9	17,9	35,2	4,9	3,8	20,8	38,8	7,0	22
34 - 53	50,0	7,5	3,9	12,8	25,8	5,0	3,8	31,6	22,9	8,7	22

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 14	2,31	1,34	1,22	11,0	1,7	115	1,92	0,98	0,10	0,12	6,08	3,12	51,3
14 – 34	1,86	1,08	1,04	10,4	1,7	82	1,14	0,68	0,08	0,14	4,90	2,04	41,6
34 - 53	1,62	0,94	0,92	10,2	3,4	73	0,88	0,68	0,06	0,14	7,26	1,76	4,2

SHEET OF DESCRIPTION NO. 13

Profile No.: 900 m of the track S 10
Vegetation: Perennial culture (cocoa)
Physiography - form: Lower slope
Slope: 2 - 5 %
Typology of the soil: Hydromorphic colluvionn* altered ferrallitic soil

Description

00 - 16: "Dark yellowish" into wet (10 YR 4/3), not very argillaceous sablo not gravillonnaire, structure polyhedric subangulaire, porous, not very compact, many fine, average roots and very fines.

16 - 34: "Yellowish brown" into wet (10 YR 5/6), sablo-argillaceous, very little gravillonnaire (0 - 5 % of ferruginous and quartzose fine gravels, structure polyhedric subangulaire, porous, compact, many very fine and fine roots.

34 - 55: "Light yellowish brown" into wet (10 YR 6/4), argilo-sandy, very little gravillonnaire (0 - 5 % of ferruginous and quartzose fine gravels), structure polyhedric subangulaire, not very porous, compact, very few very fine and fine roots. > 55: Rainwater

Physicochemical results

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 16	17.5	2.5	3.4	31.0	45.6	5,0	3,9	11,7	7,5	4,2	30
16 – 34	20.0	5.0	2.0	26.0	47.0	5,0	3,8	14,2	7,7	6,5	32
34 - 55	27.5	5.0	3.4	22,9	41.2	4,8	3,8	16,2	10,4	5,8	34

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	T (C.E)	S	V (S/T)
00 – 16	1.69	0,98	0,81	12,1	3.4	37	1,16	0,38	0,04	0,20	4,60	1,76	38,3
16 – 34	0.86	0,50	0.59	8,5	-	32	0,72	0,34	0,02	0,18	3,20	1,26	39,4
34 - 55	0,76	0,44	0,50	8,8	-	23	0,48	0,28	0,02	0,16	3,14	0,94	29,9

SHEET OF DESCRIPTION NO. 14

Profile No.: 1.000 m of the track S 10
Vegetation: Perennial culture (cocoa)
Physiography - form: Higher slope (V19)
Slope: > 10 %
Typology of the soil: Modal altered ferrallitic soil (6.11)

Description

00 - 12: " Reddish brown " into wet (5 YR 4/4), argilo-sandy with argillaceous, very little gravillonnaire (0 - 5 % of ferruginous and quartzose fine gravels), structure polyhedric subangulaire, porous, compact, many fine, very fine and average roots.

12 - 36: " Yellowish red " into wet (5 YR 4/6), argillaceous, little gravillonnaire (5 - 15 % of ferruginous and quartzose fine gravels and quartz stones), structure polyhedric angular, not very porous, compact, many very fine, fine and average roots.

36 - 64: " Red " into wet (2,5 YR 4/6), argillaceous, fairly gravillonnaire (30 - 50 % of ferruginous and quartzose fine gravels and quartz stones), angular structure polyhedric, far from porous, compact, many very fine and fine roots.

64 - 92: " Red " into wet (2,5 YR 5/6), argillaceous, little gravillonnaire (5 - 15 % of ferruginous fine gravels and quartz stones), angular structure polyhedric, far from porous, compact, very few very fine and fine roots.

> 92: Rainwater

Physicochemical results

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 12	50,0	5,0	4,1	21,4	19,5	4,5	3,6	25,2	18,6	6,6	32
12 – 36	57,5	7,5	3,0	13,2	18,8	4,5	3,6	29,5	20,5	9,0	30
36 - 64	60,0	7,5	4,1	10,4	18,0	4,6	3,7	54,0	30,9	23,1	28

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca⁺⁺	Mg⁺⁺	K⁺	Na⁺	T (C.E)	S	V (S/T)
00 – 12	2,31	1,34	1,27	10,6	6,8	110	1,74	0,58	0,10	0,10	9,08	2,52	27,8
12 – 36	2,03	1,18	1,12	10,5	4,4	101	1,14	0,38	0,06	0,10	9,18	1,68	18,3
36 - 61	1,75	1,02	0,92	11,1	1,7	137	0,88	0,36	0,01	0,08	9,72	1,36	14,0

SHEET OF DESCRIPTION NO. 15

Profile No.: P1 (above the Colonel camping field)
Vegetation: Forest Recru
Physiography - form: Summit of together setting (U.C.26)
Slope: 2 - 5 %
Typology of the soil: Hardened altered ferrallitic soil (6/13 IV)

Description

00 - 15: "Dark brown" into wet (7,5 YR 3/2), argilo-sandy, not gravillonnaire, structure polyhedric subangulaire, porous, movable, many fine, very fine, average and coarse roots.

15 - 30: "Dark brown gold brown" into wet (7,5 YR 4/2), sablo-argillaceous with argillaceous, not gravillonnaire, polyhedric structure subangulaire porous, movable, many very fine, fine, average and coarse roots.

30 - 53: "Brown" into wet, (7,5 YR 5/3), argilo-sandy, fairly gravillonnaire (30 - 50 % of ferruginous and quartzose fine gravels), structure polyhedric angular, porous, not very compact, very few very fine roots.

53 - 83: "Strong brown" into wet (7,5 YR 5/6), argilo-sandy, gravillonnaire (50 - 70 % of ferruginous and quartzose fine gravels, structure polyhedric angular, not very porous, not very compact, rare very fine roots.

> 83: Carapace

Physicochemical results

Horizon (cm)	Particle size (% of weight dried with the air)					Acidity		Hydrodynamic Characteristic			
	Clay Silt	fine Silt	Large. Sand	Fine Sand	Coarse Sand	pH Water	pH Kcl	pF 2,5	pF 4,2	Available Water	C.E.E
00 – 15	22,5	2,5	5,7	29,4	39,9	5,4	4,5	11,1	76,5	3,6	50
15 – 30	27,5	5,0	10,1	13,2	44,2	4,9	4,0	11,5	6,3	5,2	22
30- 53	27,5	5,0	3,1	16,9	47,5	5,0	4,0	12,8	8,3	4,5	13
53 - 83	25,0	2,5	3,7	26,0	42,8	5,0	3,9				

Horizon (cm)	Organic Matter				PHOSPHORUS ppm		Cation Exchangeable Meq/100 G of Soil				Complexes Absorbent		
	M.O (%)	C (%)	N (°/°°)	C/N	Assim	Tota	Ca⁺⁺	Mg⁺⁺	K⁺	Na⁺	T (C.E)	S	V (S/T)
00 – 15	2,68	1,56	1,37	11,4	9,6	115	2,54	0,92	0,12	0,46	5,90	4,04	68,5
15 – 30	1,14	0,66	0,81	8,2	1,9	78	0,92	0,62	0,08	0,10	3,92	1,72	43,9
30- 53	1,03	0,60	0,73	8,2	2,4	110	0,84	0,52	0,06	0,08	4,32	1,50	34,7
53 - 83	1,03	0,60	0,62	9,7	3,4	133	0,84	0,58	0,04	0,08	4,16	1,54	37,0