FIGURE Ⅲ.2 CLIMATIC ZONE MAP OF WEST AFRICA

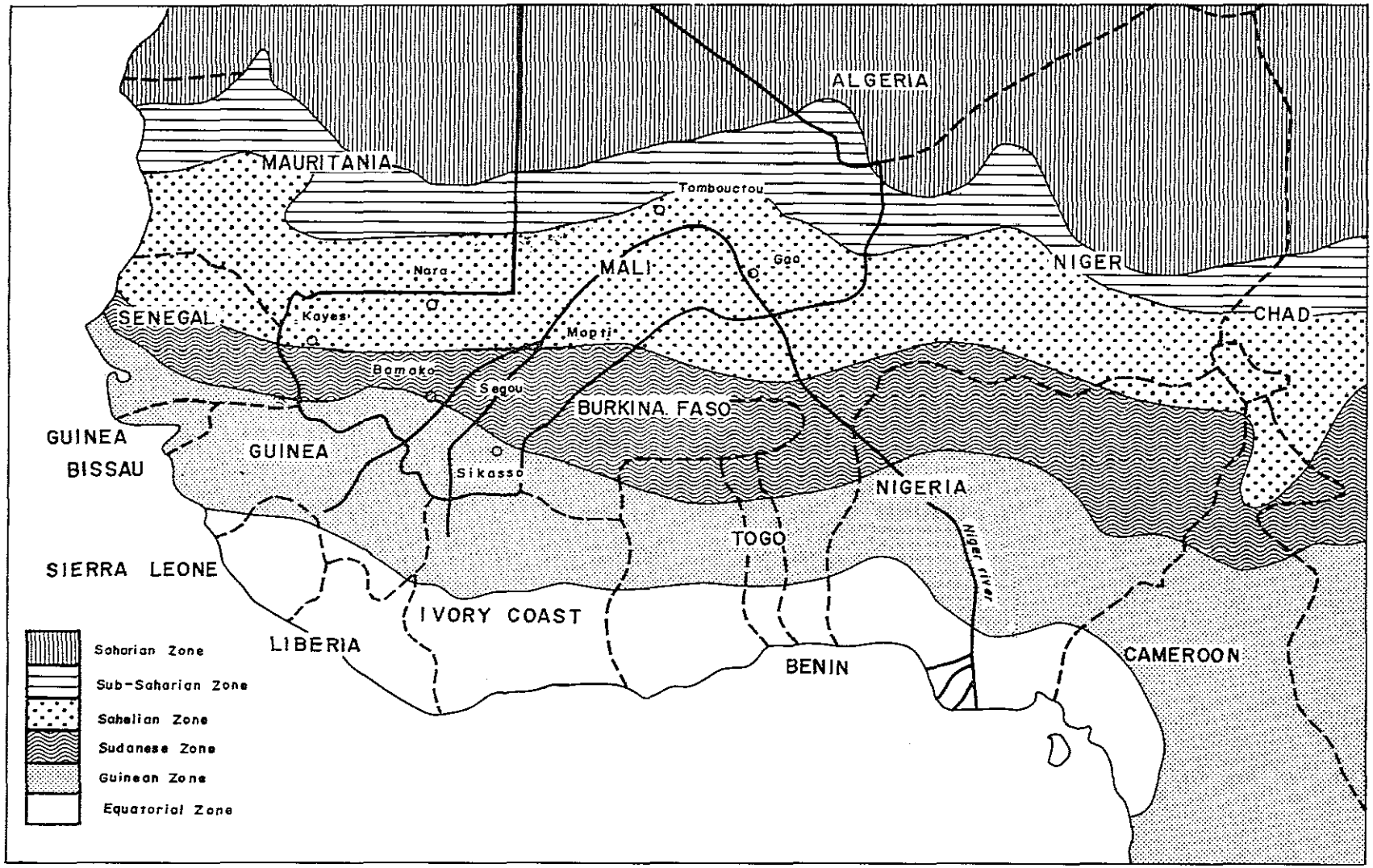


FIGURE Ⅲ-3 PRESENT LAND USE MAP

LEGEND

Mapping Symbol	Land Use Category Upland crop field	Area (ha)	Proportional Extent (%)
	Cultivated land	460	10.2
	Fallow land	3,350	77.4
	Paddy	280	6.3
	Orchard	40	0.9
	Bush and Shrub	350	7.8
	Villages and others	20	0.4
	Total	4,500	100.0

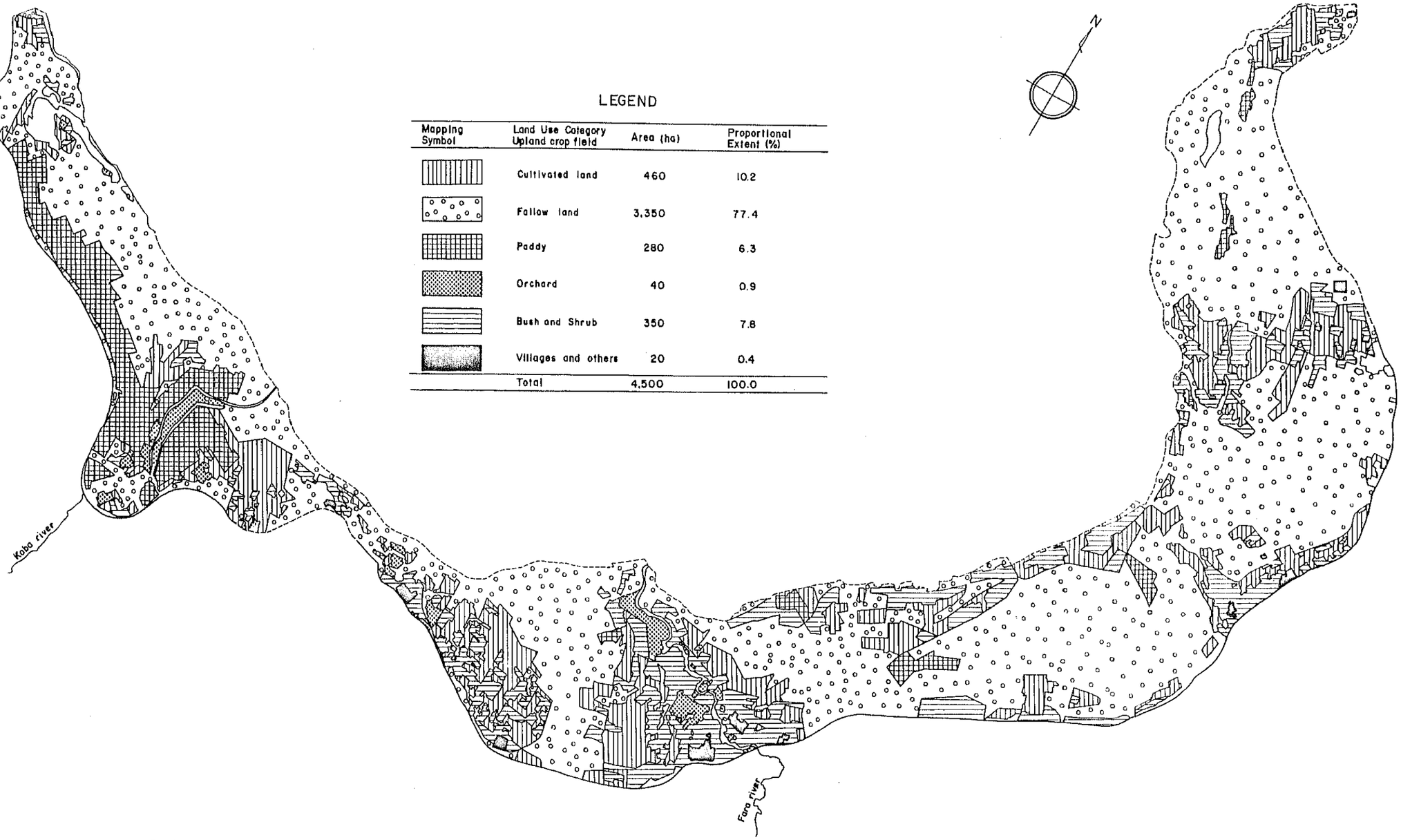
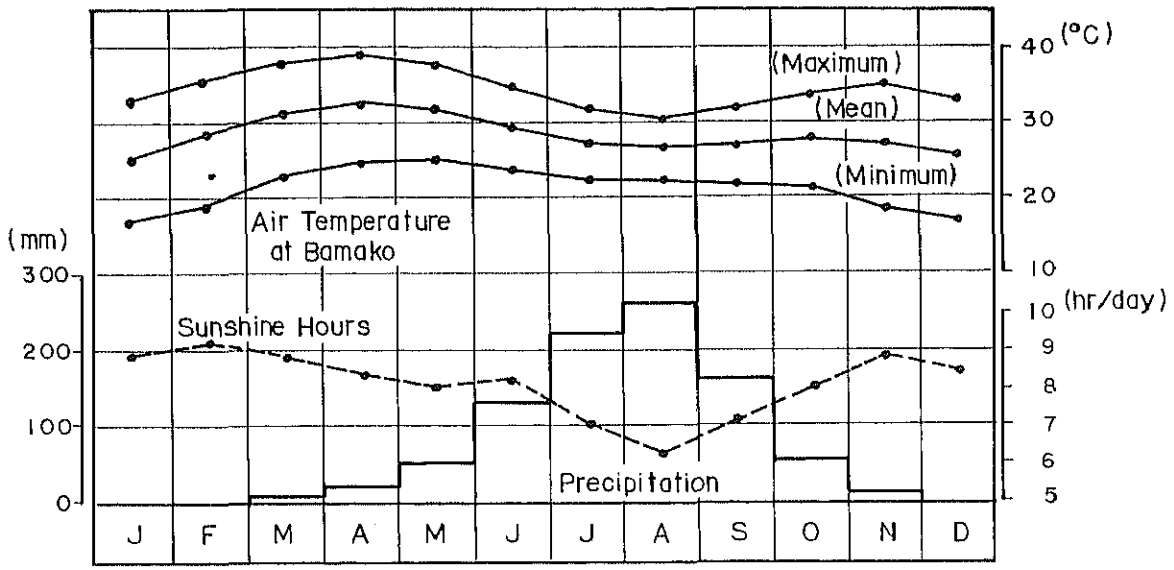


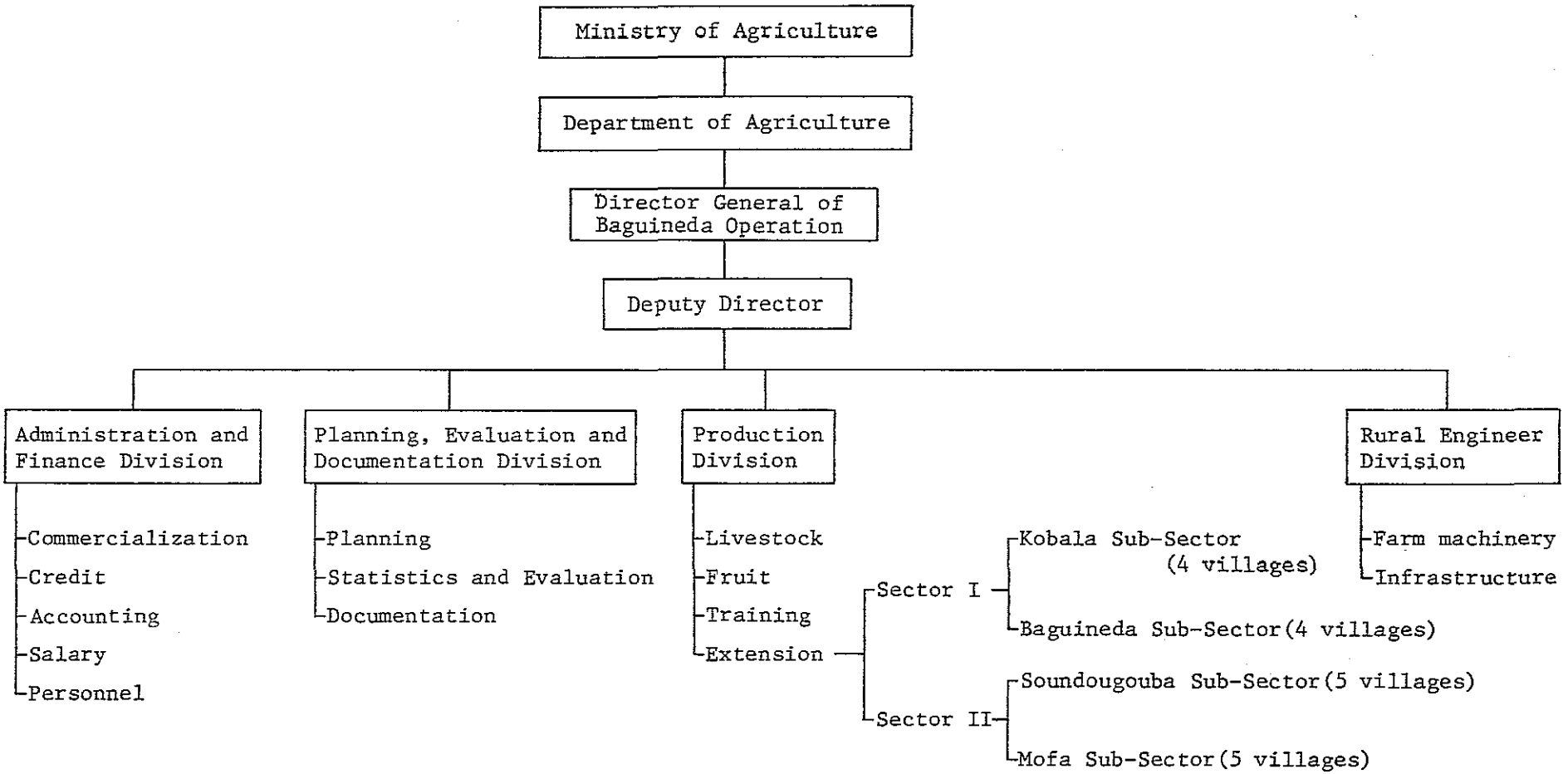
FIGURE Ⅲ - 4 PRESENT CROPPING PATTERN

Crop	Planted Area (ha)	J	F	M	A	M	J	J	A	S	O	N	D
Rice	280							○	○			×	×
Maize	220						○	○		×	×		
Sorghum & Millet	230						○	○			×	×	
Tomate	150	○	○	×						○	○	△	△×
Onion	80	○	○	○	×						○	○	△
Other Vegetables	40	○	×	×			○	○		×	×	×	×
Mango		○	○	○	×	○	○	×					



Remarks : ○------○ Seeding
△------△ Transplanting
×------× Harvesting
○——————× Growth stage

FIGURE III.5 ORGANIZATION CHART OF BAGUINEDA OPERATION



ANNEX IV

EXISTING IRRIGATION AND DRAINAGE FACILITIES

ANNEX IV

EXISTING IRRIGATION AND DRAINAGE FACILITIES

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ANNEX IV

EXISTING IRRIGATION AND DRAINAGE FACILITIES

IV.1 General

The Baguineda project area is provided with irrigation and drainage facilities that have been constructed 50 years ago. These facilities consist of headworks constructed at 5 km to the east of Bamako, 3-main canals, i.e. Sotuba, Baguineda, and Tanima main canals, secondary irrigation canals, the Tanima main drainage canals, as well as secondary drains. Two rivers cross the project area i.e., the Koba and the Fara rivers. (See Fig. IV.1)

Due to deterioration, the present irrigation and drainage system meets only very partially the requirements. The main characteristics and present conditions of the existing facilities are described hereinafter.

IV.2 Headworks

IV.2.1 Sotuba intake weir

The weir has been constructed across the Niger river at about 5 km to the east of Bamako city. The length is 1,015 m and the maximum height is 3.75 m, and it is made of concrete. There is a movable weir of 54 m long, 4 units of gates, 10 m wide and 5 m high, at the right side and of the weir. The movable weir was constructed at the time of the Sotuba hydropower plant construction in 1950's.

The main characteristics and present conditions of these structures are summarized as below.

(1) Fixed weir

Structure	:	concrete and masonry
Length	:	1,000 m
Level of the top	:	El. 316.35 m
Present condition of the structure	:	A few fissures are observed on the structure surface

(2) Movable weir

Structure	:	reinforced concrete
Total length	:	54 m
Gates	:	4 units with a width of 10 m and a height of 5 m each, of hand control type
Present condition	:	this structure is in a good condition although water leakage occurs at grooves of gates.

IV.2.2 Sotuba intake structure

This structure has been constructed at 25 m upstream of the movable weir so as to divert water required for operation of the Sotuba hydropower plant and for irrigation of the Baguineda project area.

The main characteristics and present condition of the structure are as follows:

Structure	:	reinforced concrete
Total width	:	67 m

Gates	:	8 units with 7.5 m of width and 5 m of height each, of stop log type
Water intake capacity	:	more than 230 m^3/sec
Present condition	:	good

IV.2.3 Sotuba headrace

The headrace has been constructed between the above-mentioned intake structure and the Sotuba hydropower plant and the inlet of the Sotuba irrigation canal. At present, the hydropower plant is generating 4.4 MW of electric power using 120 m^3/sec of water with the hydraulic head of 3 - 7 m./1 The main features and present condition of the headrace are summarized as follows:

Length	:	2,900 m
Bottom width	:	50 m (varies from 67 m to 25 m)
Side slope	:	1/2
Depth	:	7 m
Structure	:	earth
Gradient	:	1/10,000
Water conveying capacity	:	more than 230 m^3/sec
Present condition	:	a part of the bank slope is eroded and covered with grasses

IV.2.4 Inlet of the Sotuba irrigation canal

The inlet of the Sotuba irrigation canal is located at the downstream end of the above-mentioned headrace, where the headrace is bifurcated into one for the hydropower plant and the other, for the Sotuba irrigation canal. Irrigation water is diverted through this inlet and conveyed to the gate structure located at about 120 m downstream of the bifurcation point. The gate structure is a key structure for the whole Baguineda irrigation system and controls the irrigation intake discharge for the whole irrigation system. The main characteristics and present conditions of these inlet structures are summarized as follows:

Remark: /1: As to the extension plan of the Sotuba hydropower plant, refer to ANNEX I.

(1) Inlet canal (from headrace to the gate structure)

Type	:	excavation in rock
Length	:	124 m
Size of cross section	:	width : 9.5 m depth : 6.5 m
Water conveying capacity	:	10.4 m^3/sec
Average gradient	:	1/12,000
Present condition	:	good

(2) Sotuba gate structure

Structure	:	reinforced concrete
Width	:	9.5 m
Gate size	:	2.5 m wide and 2.5 m high each
Number of gates	:	2
Gate operation	:	electrically driven
Water conveying capacity	:	10.4 m^3/sec
Present condition	:	good

IV.3 Main Irrigation Canals

IV.3.1 Sotube main canal

The Baguineda project area is supplied with water by three main canals, viz. Sotube main canal, Baguineda main canal and Tanima main canal.

The Sotuba main canal extends between the Sotuba intake and the Baguineda gate which is provided at the beginning point of the Baguineda main canal. This canal which is constructed along the Niger river, has two functions: the first is to irrigate the Koba area and the other is to convey irrigation water to the Baguineda main canal.

The Sotuba main canal runs in the highest part of the project area, the layout of which is more or less in parallel with the contours. The canal is of earth type, except for a masonry portion of about 800 meters long. The canal lacks the right bank embankment in several portions i.e., at the Koba river crossing section of about 1.4 km and at five sporadic sections of about 4.5 km in total. At such portions, the water surface extends to the right bank creating swampy and marsh lands.

The main characteristics of the said canal are summarized below:

Type	:	earth
Length	:	about 19 km
Bottom width	:	15 m
Depth	:	3 m
Gradient	:	1/20,000
Water conveying capacity	:	10.4 m^3/sec

The Sotuba canal undergoes considerable deterioration in both the embankment portion and the masonry portion, causing severe water leakage, in the downstream section of about 6 km.

Water leakage was measured during the previous feasibility study and the results were obtained as shown in Table IV.1. For the whole length of the Sotuba canal, the leakage rate is about 280 lit./sec/km, while the most severe leakage occurs in the downstream section of the Sotuba canal from the Konini bridge to the Kobala bridge for about 3 km with the rate of 610 lit./sec/km.

Related structures to the Sotuba canal consist of turnouts, spillways, cross drains, bridges, etc. Inventory surveys on these structures have been made twice, at first in the previous feasibility stage in 1980 and at the present stage in 1985. The results of these surveys are summarized in Table IV.2.1 - IV.2.4 and in Table IV.5, respectively.

The Sotuba main canal is provided with 10-turnouts, which are equipped with sluice-gates of approximately 0.7 x 0.7 - 0.8 x 0.8 m and concrete pipes of ø400 - 500 mm. Most of them are suffered from severe deterioration and can hardly be well functioned. Besides, all of them are lacking of discharge measuring devices.

The Sotuba canal has 7-spillways to evacuate excess water of canal, most of which flows into the canal from the right bank area because of lack of embankment. They are located: 2 at Salibougou, 2 at Dougourakoro, 2 at the Koba crossing point, and 1 at just upstream of the Baguineda check gate. The spillways consist of the overflow type weir combined with several sluice gates. The weirs are constructed of reinforced concrete and gates are made of steel leaves of about 1 meter wide. Except the gates and related structures which cause considerable amount of leakage, the weir body itself is still kept at rather good condition.

There are 12-cross drains to pass drainage water from the right bank to the left bank area under the canal bottom. Structurally, they consist of inlet and outlet structures made of concrete or masonry, and of corrugated steel or concrete pipes whose diameters range from 1,000 to 1,500 mm. The inlet and outlet structures are kept at rather good condition, whereas the pipe portions seem to have some cracks and have been sedimented partially.

Four bridges are existing in the Sotuba canal at Sotuba, Dougourakoro, Konini and Kobala. Among them, the bridge at Kobala was broken during the present survey period and unusable, while the remaining bridges are usable at present, though some rehabilitation works are needed in their upper-structures.

IV.3.2 Baguineda main canal

The Sotuba canal is followed in succession by the Baguineda main canal of 17.8 km, whose characteristics are summarized as follows.

Type	:	earth
Length	:	17.8 km
Bottom width	:	6 to 9 m
Depth	:	2.5 m
Gradient	:	1/27,300
Water conveying capacity	:	8.5 m^3/sec

Similar to the Sotuba canal, the Baguineda canal is also suffered from severe leakage, especially in the first 6 km of the canal. According to the field measurement in the previous feasibility study period, the leakage rate amounts to about 470 lit./sec/km in this section. (Ref. to Table IV.1)

The related structures to the Baguineda canal comprise: 1-head regulator, 12-turnouts, 1-spillway, 8-cross drains, 10-bridges, etc.

The head regulator is located at the conjunction between the Sotuba canal and the Baguineda canal. It consists of a steel sluice gate, 5 m wide and 2 m high, and operated manually. The regulator is kept at rather good condition and will be well functioned with minor rehabilitation works such as mortar plastering of piers and walls.

Conditions of other related structures are almost the same as those of the Sotuba main canal, and in order to recover the functions, rehabilitation and, for some structures, replacement are needed.

IV.3.3 Tanima main canal

The Tanima main canal has been constructed to irrigate the Tanima area lying in the easternmost part of the project area. At present, the canal receives water from the Baguineda irrigation canal and drainage water from a part of the Baguineda area located to the right bank of the Fara river. The main characteristics of the Tanima canal are given as follows.

Type	:	earth
Length	:	6 km
Bottom width	:	5.5 m
Depth	:	1.3 m
Gradient	:	1/5,600
Water conveying capacity	:	2.10 m^3/sec

The canal has been eroded and damaged severely throughout its whole length, and due mainly to the severe leakage in the Sotuba and Baguineda canals, the Tanima canal can seldom receive adequate irrigation water.

The canal is provided with such related structures as 1-head regulator at the beginning point, 3-turnouts, 2-cross drains, 1-bridge, etc. Conditions of these structures are almost the same as those of the other main canals.

IV.4 Secondary and Tertiary Canals

IV.4.1 Koba area

Koba area is irrigated by 10 secondary canals most of which are of the embankment type. Total length is 8.9 km and the conveyance capacity of each canal is 600 to 700 lit./sec. On an average, the bottom width is 1.0 - 2.0 m, the canal height is 1.0 - 1.5 m, the hydraulic gradient is 1/150 - 1/300.

These secondary canals are being used at present. However, their functions have been reduced considerably due to erosion of banks, sedimentation, dense growth of weed, etc. The main characteristics of the secondary canals are summarized in Table IV.3 and their locations are shown in Fig IV.5.

The secondary canals of the Koba area are provided with: 130-turnouts, 43-checks, 1-drop, 2-culverts, etc. The turnouts are generally made of metal pipes of dia. 200 to 300 mm and are located at an approximate interval of 50 m. The checks are made of masonry and equipped with stoplogs. They are located at an interval of 50 to 100 m. Most of these secondary canals' structures have been deteriorated and are out of function.

The tertiary canals are branched from the secondary canals at an interval of about 50 m. Because of poor maintenance by farmers, most of the tertiary canals are out of function at present.

IV.4.2 Baguineda area

The Baguineda area is served by 14 secondary canals of 19.9 km long in total. Similar to those for the Koba area, they are generally of the embankment type and take the longitudinal gradient of 1/1,200 to 1/1,000. The canal capacity ranges from 700 to 900 lit./sec. The main characteristics of the Baguineda secondary canals are shown in Table IV.3 and their locations are indicated in Fig.IV.5.

Deterioration of the secondary canals in the Baguineda area is more severe than those of the Koba area, since use of these canals are quite limited due to inadequate water supply from the Baguineda main canal.

The related structures to the Baguineda secondary canals comprise: 43-turnouts, 12-drops, 1-check, 1-culvert, etc. Types and dimensions of all these structures are almost the same as those of the structures for the Koba area.

The tertiary canals are also branched from the secondary canals. However, most of them are hardly usable due to poor maintenance by farmers.

IV.4.3 Tanima area

There are 4 secondary canals in the Tanima area, with a total length of about 5.8 km. Three of them are to convey water coming from the three turnouts provided on the Tanima main canal; the fourth one, named "the Sienkoro secondary canal" is used to divert water directly toward the Sienkoro area through a water intake structure constructed in the downstream of the Baguineda drain. All the canals have been constructed of earth and provided with small banks on both sides: They can convey an amount of 200 to 400 lit./sec of water. In principle, they are located at an interval of 700 to 800 m. The canals are completely deteriorated and cannot be functioned at present.

Main characteristics of the secondary canals of the Tanima areas are given in Table IV-3 and the layouts of these canals are shown in Fig. IV-5.

The canal structures consist of 12-turnouts, provided at 300 to 400 m intervals. All of these turnouts are seriously deteriorated.

The tertiary canals have been provided at 300 to 400 m intervals. They have been constructed of earth and cannot be operated at present because of their severe deteriorated condition.

IV.5 Koba and Fara Rivers and Main Drain

IV.5.1 Koba river

The Koba river crosses the Sotuba main canal and falls into the Niger river after passing through the project area. It discharges all its water in the Sotube main canal because the right bank thereof has not been embanked. Water stretches out in the right side of the canal forming a vast pond in the form of a delta. The Koba flood water is intended to be drained off through two spillways provided on the left bank of the canal.

According to statistical analysis of the Koba hydrological data, the flood runoff is estimated at 135 m^3/sec at Kobala based on maximum daily precipitation with a 1/10 probability.

The main characteristics of the two spillways are as summarized below.

Spillway-A:

Type	:	overflow type concrete weir provided with 7-spans of under-sluices
Dimensions	:	47 m long, 1.75 m wide and 2.1 m high
Dimensions of a metal gate	:	1.1 m wide and 2.1 m high
Number of gates	:	7
Control method	:	by man hand
Drained off discharge	:	39 m^3/sec at water level of 316.65 m which corresponds to a flood discharge level with 1/10 probability

The structure of this weir is not damaged, but a large amount of water leakage has been observed around the gate grooves.

Spillway-B:

Type	:	the same as Spillway-A
Dimensions	:	46 m long, 1.70 m wide and 2.1 m high
Dimensions of a metal gate	:	1.1 m wide, 1.1 m high
Number of gates	:	7
Control method	:	by man hand
Drained off discharge	:	55 m^3/sec at water level of 316.65 m

The structure of this weir is also intact, but a large amount of water leakage has also been found around the gate grooves.

IV.5.2 Fara river

The Fara river passes under the Baguineda main canal through the cross drain constructed under the canal bottom.

According to the frequency analysis, the flood runoff is estimated at 23 m^3/sec at the crossing point based on maximum daily precipitation with a 1/10 probability. The downstream part of the river has a relatively narrow cross section and a lot of windings.

The main characteristics of the cross drain under the canal are as follows:

Type	:	box culvert
Structure	:	masoned bricks
Dimensions of a box culvert barrel	:	0.9 m wide and 1.25 m high
Number of box culverts	:	4
Length	:	34 m

This structure is at present functioning poorly because of its deteriorated condition, causing a large amount of water leakage.

IV.5.3 Tanima main drain

The Tanima main drain starts in the north of Sebela village and passes through the lower part of the Baguineda area, collects excess water coming from the Tanima area, and drains it off towards the Niger river. On the way, it feeds water to the existing Tanima irrigation canal.

The drain consists of a 3.2 km long part in the Baguineda area and a 4.0 km part in the Tanima area with total length of 7.2 km.

The main characteristics of the drain are as follows:

	Upstream part (3.2 km long)	Downstream part (4.0 km long)
Cross section		
- Bottom width	2.0 m	4.0 m
- Side slope	1/1	1/1
- Depth	1.3 m	2.0 m
- Gradient	1/750	1/1,000
- Drainage capacity	3.0 m^3/sec	7.5 m^3/sec

The Tanima main drain is covered with grass and is deteriorated considerably. Especially, the downstream part located in the Tanima area is insufficient in capacity for draining off large floods.

Related structures to the Tanima drain consist of a diversion structure to the Tanima irrigation canal and 4-road crossing culverts. The former is rather deteriorated, however, the latter are kept at good condition and usable.

IV.6 Secondary Drains

The Koba area is provided with 11-secondary drains with a total length of 14.9 km. Among them, 6-drains are for draining water from the inside of the project area, while the remaining 5-drains are to convey water mainly from the southern side of the Sotuba main irrigation canal.

The Baguineda area has 13-secondary drains with a total length of 26.4 km. Five drains are for drainage of water within the project area, whereas 7-drains are to convey water mainly from the right side area of the Baguineda main irrigation canal.

As regards the Tanima area, there are 6-secondary drains with a total length of 7.2 km. All of these drains flow into the Tanima main drainage canal.

Generally speaking, all the secondary drains are not functioned well due to erosion and thick weed growth. Besides, the related structures, such as drops and regulators, have been deteriorated considerably reducing the drainage capacity.

The main characteristics and conditions of the secondary drains are summarized in Table IV.4.

IV.7 Tertiary Blocks

Tertiary blocks are defined as terminal irrigation blocks which are commanded by tertiary irrigation and drainage canal systems.

Compared with those in other areas, the tertiary blocks in the Koba area have been rather well developed. The tertiary canal is provided at an approximate interval of 50 m and the quaternary canal or supply ditch is provided at an interval of about 20 m.

In the Baguineda and Tanima areas, the tertiary blocks have not been well developed. The spacing of the tertiary irrigation canal is about 100 - 200 m, while the quaternary canal is scarcely provided.

IV.8 Road Network

The road network in the project area consists of a main road and farm tracks. The main road runs along the left embankment of the main canal; it has a length of 37 km and an effective width of 4 m; its surface is paved with laterite. This road connects the Sotuba sector and Tanima sector, and affords passage of car only during the dry season. It is used not only for farm operation but also for travelling of people from village to village. Generally, the road pavement is in poor condition. The road running along the Tanima main canal has a length of 6 km and an effective width of 2 m. It is in poor condition and automobile traffic is hardly possible.

The farm tracks have been constructed along secondary canals or along drains. They have an effective width of 2 m, and are not usable for automobile traffic because of their deterioration.

There are 14-bridges on the main canals, all of which have been constructed with concrete slabs and masoned stone pillars, with mortar finishing. The effective width of pavement is about 5 m. The bridges are in general in good condition. However, their spacings are too long especially between Sotube and Dougourakoro. The bridge sites are shown in Fig. IV-2; the typical bridge is shown in Fig. IV-4.

Table IV.1 RESULTS OF MEASUREMENT OF WATER LEAKAGE (1/2)

Point of Measurement	Accumulated Distance (km)	Discharge Measured (m^3/sec)	Leakage thr. Canal (m^3/sec)	Leakage thr. Structures: Turnout Name	Turnout Discharge (m^3/sec)	Spillway Name	Spillway Discharge (m^3/sec)	Cross Drain Name	Cross Drain Discharge (m^3/sec)	Sub-total (m^3/sec)	Total Loss (m^3/sec)	Remarks
Sotuba Main Canal												
No. 1+98	0	7.185										
No. 6+21								S_1	-			
No. 14+90								S_2	-			
No. 28+88								S_3	-			
No. 29+51 - No.30+39						A	0.40			0.40		
No. 35+51 - No.36+76						B	0.40			0.40		
No. 41+38								S_4	-			
No. 58+20								S_5	-			
No. 67+88								S_6	-			
No. 75+48								S_7	-			
No. 85+81						No.1	0.20			0.20		
No. 97+42						No.2	0.05			0.05		
No. 107+28				K1	-							
No. 108+92	10.694	5.292	0.843							1.05	1.893	
No. 111+94				K2	0.05					0.05		
No. 116+15								S_8	-			
No. 117+52				K3								
No. 123+42				K4	0.10					0.10		
No. 126+77								S_9	-			
No. 129+72				K5	0.10					0.10		
No. 133+50	13.152	4.867	0.175							0.25	0.425	
No. 133+89				K6	0.10					0.10		
No. 139+15												
No. 142+33								S_{10}	-			
No. 144+29				K7	0.10					0.10		
No. 147+30				K7 Bis	0.05					0.05		
No. 148+67						Koba	0.20			0.20		
No. 153+67								Kobe	0.10	0.10		
No. 161+66						Koba	0.20			0.20		
No. 164+27	16.229	2.986	1.131							0.75	1.881	

Table IV.1 RESULTS OF MEASUREMENT OF WATER LEAKAGE (2/2)

Point of Measurement	Accumulated Distance (km)	Discharge Measured (m^3/sec)	Leakage thr. Canal (m^3/sec)	Leakage thr. Structures: Turnout Name	Turnout Discharge (m^3/sec)	Spillway Name	Spillway Discharge (m^3/sec)	Cross Drain Name	Cross Drain Discharge (m^3/sec)	Sub-total (m^3/sec)	Total Loss (m^3/sec)	Remarks
No. 164+34				K_8	0.45					0.45		
No. 168+26								S_{11}	-			
No. 170+46				K_9	0.01					0.11		
No. 176+8				K_{10}	0.01					0.11		
No. 178+24								S12	-			
No. 189+96	18.798	1.958	0.558							0.47	1.028	
Baguineda Main Canal												
No. 0	0	3.606										
No. 12+52	1.252	2.271	1.335							0	1.335	
No. 16+41				B_1	0.01					0.01		
No. 24+61				B_2	-							
No. 25+91	2.591	1.213	1.048							0.01	1.058	
No. 29+81				B_2 Bis	0.01					0.01		
No. 34+81	3.481	0.953	0.250							0.01	0.260	
No. 40+75				B_3	-							
No. 48+48								S14	-			
No. 51+45				B_4	-							
No. 53+46								S15	-			
No. 59+72				B_5	-							
No. 60+61	6.061	0.712	0.241							0	0.241	

Remarks: 1) During the survey period, there was no water in the downstream 12 km of the Baguineda canal. Water loss in this section is estimated as follows:

$Qf = W \times L \times K$ where, QF: Water loss (leakage through canal and structures)
W: Wetted perimetre of canal, assumed at 9.6 m
K: Co-efficient of permeability, 1.2×10^{-6} m/sec

Based on the above, QF is estimated at 11 lit./sec/km.

2) The water loss in the Tanima canal is estimated with the same formula as above. It is estimated at 10 lit./sec/km.

Table IV.2-1 DIMENSIONS AND ACTUAL CONDITIONS OF EXISTING TURNOUTS (1/3)

Name	Location	Dimension					Actual Situation					
		Inlet W x L x H (m)	Gate (m)	Pipe	Outlet	Transition W x L x H (m)	Inlet	Water Proof of Gate	Structure	Pipe	Outlet	Transition
Sotuba main canal												
K-1	No.107 + 28	1.2 x3.0 x2.0	0.8 x0.8	ø400 mm L = 8.0 m	0.3m x 0.3m	0.55 x 2.0 x2.0	o	×	×	o	o	×
K-2	No.111 + 94	1.2 x3.0 x2.2	0.8 x0.8	ø400 mm L = 8.4 m	2.6m x 2.2m	-	o	×	×	o	o	×
K-3	No.117 + 52	0.8 x2.0 x2.0	0.7 x0.7	ø500 mm L = 4.7 m	ø500 mm	0.8 x1.2 x1.8	o	×	×	o	o	×
K-4	No.123 + 42	3.0 x2.0 x2.8	0.7x0.7x2 0.5x0.5x1	ø400 mm x2 ø600 mm x1 L = 8.0 m	W H 1.5mx2.8mx3	Wall of block L = 65 m	o	×	×	o	o	×
K-5	No.129 + 72	2.4 x2.0 x2.0	0.7x0.7x2	ø400 mm x1 ø500 mm x1 L = 8.0 m	400 mm x1 500 mm x1	Wall W = 6 m	o	×	×	o	o	×
K-6	No.133 + 89	2.2 x2.0 x2.2	0.7x0.7x2	ø400 mm x2 L = 8.0 m	W L 0.4mx0.6mx2	2.0 x1.0 x2.2	o	×	×	o	o	×
K-7	No.144 + 29	-	0.7 x0.5	ø400 mm L = 7.0 m	ø400 mm	-	o	×	×	o	o	×
K-7 Bis	No.147 + 30	-	1.8 x2.8	L = 7.8 m	ø800 mm	0.5 x 2.0 x1.2	o	×	×	o	o	×
K-8	No.164 + 34	2.4 x2.0 x2.2	0.8x0.8x2	ø700 mm x1 ø400 mm x1 L = 8.1 m	ø700 mm x1 ø400 mm x1	0.6 x1.0 x2.0 0.9 x1.4 x1.8	o	o	×	o	o	×
K-9	No.170 + 46	1.2 x2.0 x2.2	0.7 x0.7	ø400 mm L = 8.6 m	ø400 mm	0.9 x1.7 x1.8	o	×	×	o	o	×
K-10	No.176 + 8	1.0 x2.0 x1.2	0.7x0.7x2	ø400 mm x2 L = 8.5 m	ø400 mm x2	0.5 x1.2 x1.4 1.0 x1.2 x1.1	o	×	×	o	o	×

Remarks: W: Width L: Length H: Height ø: Diameter o: Good condition ×: Bad condition

Table IV.2-1 DIMENSIONS AND ACTUAL CONDITIONS OF EXISTING TURNOUTS (2/3)

Name	Location	Dimension					Actual Situation					
		Inlet W x L x H (m)	Gate (m)	Pipe	Outlet	Transition W x L x H (m)	Inlet	Water Proof of Gate	Structure	Pipe	Outlet	Transition
Sotuba main canal				W H	W H							
B-1	No.16 + 41	1.0 x1.7 x2.0	0.5 x0.6	0.4 x0.5 L = 4.8 m	0.4m x0.5m	1.0 x2.5 x1.3	o	×	×	o	o	×
B-2	No.24 +61	0.9 x1.7 x1.8	0.6 x0.3	ø300 mm L = 5.0 m	ø300 mm	-	o	×	×	o	o	×
B-2 Bis	No.29 + 81	0.4 x1.5 x1.3	0.5 x0.5	ø400 mm	ø400 mm	0.6 x1.0 x1.4	o	×	×	o	o	×
B-3	No.40 + 75	0.9 x1.3 x1.3	0.6x1.0x2	ø500 mm	ø500 mm	0.6 x1.2 x1.2	o	×	×	o	o	×
B-4	No.51 + 45	1.0 x2.0 x1.8 1.0 x2.0 x1.4	0.5x0.5x2 0.6x0.6x1	ø300 mm x 2 ø400 mm x 1 L = 5.0 m	ø300 mm x 2 0.5m x 5m x 1	0.5x1.0x1.8x2 1.0x2.0x1.6x1	o	×	×	o	o	×
B-5	No.59 + 72	1.0x1.5x1.5x2	0.6x0.6x1 0.5x0.5x1	ø500 mm L = 5.2 m	0.5x0.5x2	2.0x2.0x1.8x2	o	×	×	o	o	×
B-6	No.70 + 4	1.0x2.0x2.0x2	0.6x0.6x2	ø500 mm x 2 L = 5.0 m	ø500 mm x 2	-	o	×	×	o	o	×
B-7	No.83 + 18	1.0x2.0x1.4x2	0.6x0.6x2	ø400 mm x 2 L = 6.0 m	ø400 mm x 2	0.6 x1.5 x1.0 0.4 x1.5 x1.8	o	×	×	o	o	×
B-8	No.97 + 93	0.6 x 1.5 x 1.6	0.6 x 0.5	ø500 mm L = 6.0 m	0.7m x 0.8m	-	o	×	×	o	o	×
B-9	No.116 + 77	1.4 x 2.6 x1.6	-	L = 6.0 m	-	1.4 x1.6 x1.6	o	×	×	o	o	×
B-10	No.132 + 14	0.7 x1.0 x1.8	0.7 x0.7	ø400 mm L = 8.0 m	0.5m x 0.4m	0.65 x1.6 x1.8	o	×	×	o	o	×
B-11	No.143 + 34	0.5 x1.8 x1.8	-		0.6m x 0.8m	0.8 x2.1 x1.7	o	×	×	o	o	×
B-12	No.163 + 25	0.9 x1.0 x2.2	0.7 x0.6	ø400 mm L = 6.0 m	0.7m x 0.6m	1.4 x1.8 x1.8	o	×	×	o	o	×

Remarks: W: Width L: Length H: Height ø: Diameter o: Good condition ×: Bad condition

Table IV.2-1 DIMENSIONS AND ACTUAL CONDITIONS OF EXISTING TURNOUTS (3/3)

Name	Location	Dimension					Actual Situation					
		Inlet W x L x H (m)	Gate (m)	Pipe	Outlet	Transition W x L x H (m)	Inlet	Water Proof of Gate	Structure	Pipe	Outlet	Transi-tion
Tanima main canal												
T2		1.0x2.0x1.9	-	W H 0.7m x 0.5m	0.7m x 0.5m	1.0x1.0x1.0	x	x	x	x	x	x
T3		1.0x2.0x2.0	-	ø500mm L = 6.0m	ø500mm	0.8x1.2x1.2	x	x	x	x	x	x

Table IV.2.2 DIMENSIONS AND ACTUAL CONDITIONS OF EXISTING SPILLWAYS

Name	Location	Dimensions (m)			Actual Situation				Remarks
		Length	Gate	Waterpass Conduit	Structure	Gate		Waterpass Conduit	
						Water-proof	Structure		
Sotuba Main Canal									
Gated Spillway A	No.29+51 - No.30+39	L = 44.5	1.1 x 1.1 x 4	1.0 x 1.0 x 4 L = 3.0	o	x	x	o	Gate is equipped
Gated Spillway B	No.35+54 - No.36+76	L = 45	1.1 x 1.1 x 4	1.0 x 1.0 x 2 L = 3.0	o	x	x	o	Gate is equipped
Gated Spillway	No.85+81 - No.1	L = 10.6	1.1 x 1.1 x 2	1.0 x 0.8 x 2 L = 1.7	o	x	x	o	Gate is equipped
Gated Spillway	No.97+42 - No.2	L = 10.6	1.1 x 1.1 x 2	1.0 x 0.8 x 2 L = 1.7	o	x	x	o	Gate is equipped
Gated Spillway No.1	No.147+89 - No.148+40	L = 47.3	1.1 x 1.1 x 7	0.8 x 1.0 x 7 L = 1.75	o	x	x	o	Gate is equipped
Gated Spillway No.2	No.161+41 - No.161+92	L = 46.4	1.1 x 1.1 x 7	0.8 x 0.8 x 7 L = 1.70	o	x	x	o	Gate is equipped
Gated Spillway	No.187+6 - No.188+63	L = 38.4			o	o	-	-	-
Baguineda Main Canal									
Gated Spillway	No.67+4 Fara	W L H 3.0x1.5x2.4	3.0 x 2.4	2.3 x 1.0	o	x	x	o	Gate is equipped
Gated Spillway	No.67+4 Fara	L = 19 W = 7			o	o	-	-	Side-spillway

Table IV.2-3 DIMENSIONS AND ACTUAL CONDITIONS OF CROSS DRAINS (1/2)

Name	Location	Dimension			Actual Situation				Remarks
		Inlet (m)	Pipe	Outlet (m)	Inlet	Pipe		Outlet	
						Leakage	Structure		
Sotuba main canal									
S1	No.6 + 21	W = 7.5	ø1,500 mm x 2 L = 67 m	W = 3.0	o	×	o	o	
S2	No.14 + 90	W = 1.05 H = 0.9	ø1,000 mm L = 50 m		o	×	o	o	
S3	No.25 + 88	W = 1.05 H = 0.9	ø1,000 mm L = 53 m		o	×	o	o	
S4	No.41 + 38	W = 0.9 H = 1.05	ø1,000 mm L = 53.5 m		o	×	o	o	
S5	No.58 + 20		ø1,000 mm x 2 L = 46.3m x 2		o	×	o	o	
S6	No.67 + 88	W = 1.05 H = 0.9	ø1,000 mm L = 41.50 m	W = 3.5 H = 2.1	o	×	o	o	
S7	No.75 + 48	W = 1.0 H = 0.9	ø1,000 mm H = 0.65 m L = 47 m		o	×	o	o	
S8	No.116 + 15	W = 1.05 H = 1.1	ø1,000 mm L = 44.5 m	W = 3.5 H = 1.8	o	×	o	o	
S9	No.126 + 77	W = 1.1 H = 1.2	ø1,200 mm L = 57 m	W = 3.2 H = 3.1	o	×	o	o	
S10	No.142 + 33		ø200 mm L = 46 m	W = 6.0 H = 2.0	o	×	o	o	
S11	No.168 + 26		ø1,100 mm L = 47 m	Wall W = 3.2 H = 2.2	o	×	o	o	
S12	No.178 + 24		ø1,200 mm L = 47.8 m	Wall W = 4.0 H = 2.3	o	×	o	o	

Table IV.2-3 DIMENSIONS AND ACTUAL CONDITIONS OF CROSS DRAINS (2/2)

Name	Location	Dimension			Actual Situation				Remarks
		Inlet (m)	Pipe	Outlet (m)	Inlet	Pipe		Outlet	
						Leakage	Structure		
Baguineda main canal									
S13	No.13 + 44	W = 1.0	1.0m x 2.0m L = 31 m	W = 4.4 H = 2.5	o	×	o	o	
S14	No.48 + 48		L = 31 m	Wall W = 4.0 H = 7.5	o	×	o	o	
S15	No.53 + 46		L = 26.1 m	W = 4.0 H = 3.0	o	×	o	o	
Fara S16	No.68 + 73	W = 6.0	1.4mx1.25m x 3 L = 33.6 m	6.4 x 1.4	o	×	o	o	
S17	No.75 + 44	W = 3.6 H = 2.3	L = 26.7 m	W = 4.0 H = 3.5	o	×	o	o	
S18	No.89 + 84	H = 6.0 H = 2.5	L = 26.6 m	W = 4.5 H = 3.0	o		o	o	
S19	No.97 + 93		ø2,000 mm H = 1.0 m L = 24.0 m	W = 6.0 H = 4.0	o		o	o	
S20	No.135 + 80		L = 29.3 m	W = 15.40 H = 1.60	o		o	o	
Tanima main canal									
S21			ø800 mm L = 18.5 m		o		o	o	
S22			ø800 mm L = 18.2 m						

Table IV.2-4 DIMENSIONS AND ACTUAL CONDITIONS OF EXISTING BRIDGES

Name	Location	Dimension					Actual Situation		
		Width (m)	Length (m)	Width of Parapet (m)	Pier	Abutment (m)	Parapet	Pier	Abutment
Sotuba main canal									
Sotuba	No.1 + 93	4.0	29.7	0.40		4.0	o	o	o
Dougoura koro	No.108 + 92	3.1	17.0	0.20	0.3m x5.5m x2	3.5	o	o	o
Konini	No.133 + 50	4.2	16.5	0.20		4.2	o	o	o
Kobala	No.164 + 27	4.0	17.3	0.20	0.4m x4.0m x2	6.0	o	o	o
Baguineda main canal									
Baguineda	No.12 + 52	3.0	15.0	0.20	0.4m x3.0m x2	3.0	o	o	o
Baguineda camp	No.25 + 91	6.4	8.0	0.20		6.4	o	o	o
Kogniba	No.34 + 81	2.7	11.0	0.20		2.7	o	o	o
Soundaugouba	No.60 + 61	7.0	9.6	0.20		2.0	o	o	o
Gnognan	No.69 + 95	5.0	6.0	0.25		6.6	o	o	o
Ouriguila	No.75 + 27	2.0	7.0	0.20		4.0	o	o	o
Sébéla	No.89 + 75	3.8	6.5	0.15		3.8	o	o	o
Massakoni	No.107 + 46	2.6	7.6	0.20		2.6	o	o	o
Farakan	No.134 + 54	4.5	10.0	0.20		4.5	o	o	o
Mofa	No.158 + 26	3.0	7.0	0.20		3.0	o	o	o
Tanima main canal									
Tanima		6.0	7.0			-	o	o	o

Table IV.3 PRINCIPAL CHARACTERISTICS OF SECONDARY IRRIGATION CANALS (1/2)

Sector	Name	Length (km)	Longi-tudinal Gradient	Dimension[1] (m) B	H	S1	W	S2	h	Number of Related Structures: Turn-out	Division w/drop	Check	Drop	Aqua-duct
Koba	K-1	0.28	1/300	2.0	1.0	0.7	1.2	1.3	0.5	10	-	3	-	-
Sector	K-2	0.58	1/230	1.5	1.1	1.0	1.0	3.0	0.4	10	-	3	-	-
	K-3	0.66	1/200	1.5	1.0	1.0	0.7	2.5	0.4	22	-	6	-	-
	K-4	0.62	1/190	2.0	1.5	1.0	2.0	3.0	0.5	25	-	7	-	-
	K-5	0.36	1/150	1.5	1.3	1.0	9.8	2.0	0.4	14	-	5	-	-
	K-6	0.57	1/320	2.0	0.7	1.2	1.0	1.5	0.5	14	-	5	-	-
	K-7	0.42	1/170	2.0	1.5	0.7	1.0	2.0	0.8	-	-	2	-	-
	K-7 BIS	2.03	1/1,000	1.2	1.0	1.0	1.0	3.0	0.3	1	-	-	1	-
	K-8	1.63	1/600	2.0	1.2	1.2	1.0	3.0	0.6	32	-	11	-	1
	K-9	0.68	1/150	1.0	1.0	1.2	2.0	1.0	0.3	-	-	1	-	-
	K-10	1.09	1/220	2.0	1.5	1.5	1.0	5.0	0.5	2	-	-	-	1
Sub-total		8.92								130	0	43	1	2
Baquineda	B-1	0.46	1/220	1.5	1.0	1.5	1.0	5.0	0.3	2	-	-	-	-
Sector	B-2	1.31	1/280	1.0	0.5	3.0	0.5	3.0	0.5	4	-	-	-	-
	B-2 BIS	1.90	1/320	1.0	1.0	1.4	1.0	5.0	0.3	-	-	-	-	-
	B-3	1.25	1/310	2.0	1.0	1.7	1.0	5.0	0.3	-	-	-	-	-
	B-4	1.06	1/830	1.0	0.5	2.0	1.0	5.0	0.3	2	2	-	-	-
	B-5	1.74	1/510	1.0	0.3	2.0	0.5	3.0	0.2	2	-	1	-	1
	B-6	1.26	1/790	3.0	0.3	2.0	0.5	4.0	0.3	3	4	-	-	-
	B-7	1.48	1/1,800	2.0	0.8	1.6	1.0	2.5	0.5	3	1	-	-	-
	B-8	2.22	1/850	1.5	0.4	1.5	1.0	5.0	0.3	9	1	-	-	-
	B-9	1.37	1/550	1.3	1.0	0.5	1.0	5.0	0.3	6	-	-	-	-
	B-10	2.00	1/840	1.0	0.4	3.0	0.4	3.0	0.3	5	-	-	-	-
	B-10 BIS	1.20	1/2,000	1.3	0.4	2.5	0.4	5.0	0.2	2	-	-	-	-
	B-11	1.20	1/500	1.5	0.3	2.0	0.3	4.0	0.3	4	-	-	-	-
	B-12	1.40	1/330	2.5	0.3	1.0	0.3	5.0	0.3	1	4	-	-	-
Sub-total		19.85								43	12	1	0	1

Table IV.3 PRINCIPAL CHARACTERISTICS OF SECONDARY IRRIGATION CANALS (2/2)

Sector	Name	Length (km)	Longi-tudinal Gradinent	Dimension /1 (m) B	H	S_1	W	S_2	h	Number of Related Structures: Turn-out	Division w/drop	Check	Drop	Aqua-duct
Tanima	T-1	0.69	1/480	1.5	0.3	2.0	0.3	3.0	0.4	2	-	-	-	-
Sectoe	T-2	0.68	1/270	1.5	0.4	3.0	0.3	5.0	0.3	4	-	-	-	-
	T-3	0.67	1/290	1.0	1.0	2.5	1.0	2.5	1.0	2	-	-	-	-
	Sienkero Canal	3.79	1/960	2.0	1.0	1.5	2.0	1.5	0.2	4	-	-	-	-
Sub-total		5.83								12	0	0	0	0
Total		34.60								185	12	44	1	3

Remarks: /1: Cross-section is shown as below:

Cross Section

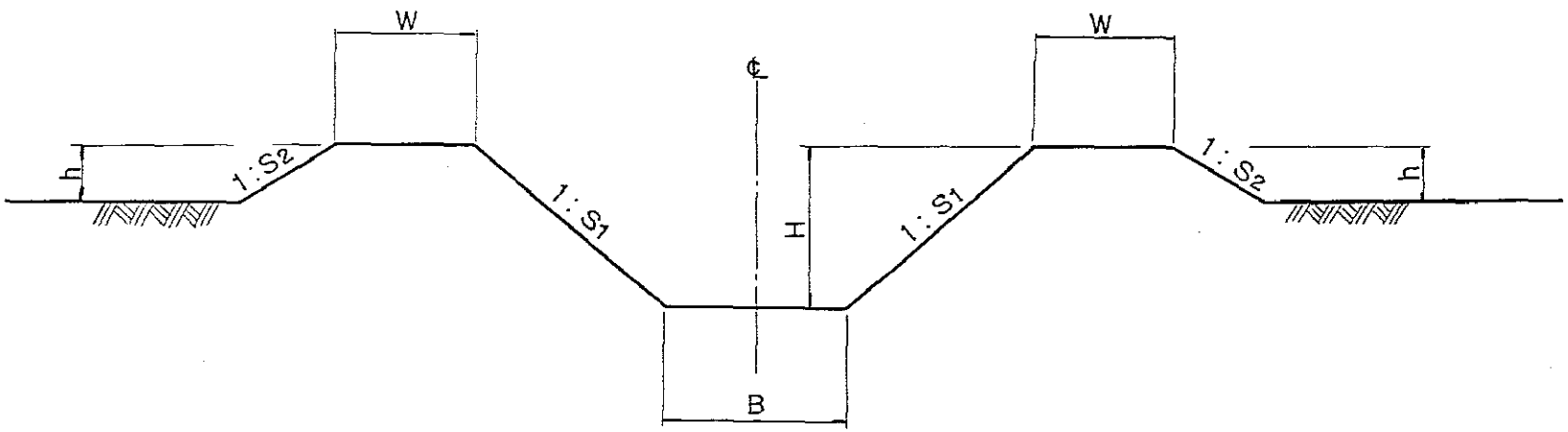


Table IV.4 PRINCIPAL CHARACTERISTICS OF SECONDARY DRAINS AND RELATED WORKS (1/2)

Sector	Name	Length (km)	Longi-tudinal Gradient	Dimension/1 (m) B	H	S	Number of Related Structure Drop	Aqua-duct	Siphon	Bridge	Check	Turn-out
Koba	DK-1	0.86	1/200	2.0	0.7	1.3	-	-	-	-	-	-
Sector	DK-2	1.01	1/330	2.0	0.8	1.2	-	-	-	-	-	-
	DK-3	1.38	1/220	2.0	1.0	1.3	-	-	-	-	-	-
	DK-4	1.46	1/220	1.5	1.0	1.2	-	-	-	-	-	-
	DK-5	1.83	1/310	2.0	1.6	1.0	-	-	-	-	-	-
	DK-6	1.06	1/270	1.5	1.3	0.7	-	-	-	-	-	-
	DK-7	0.49	1/200	2.0	1.3	2.5	-	-	-	-	-	-
	DK-8	2.56	1/460	1.6	2.5	0.6	-	-	-	-	1	-
	DK-9	2.08	1/290	2.0	2.0	0.5	-	-	-	-	-	-
	DK-10	0.90	1/240	2.0	1.0	1.3	-	-	-	-	1	-
	DK-11	1.30	1/230	2.0	1.1	1.0	-	-	-	-	-	-
Sub-total		14.93					0	0	0	0	2	0
Baquineda	DB-1	0.70	1/130	1.8	0.9	1.3	-	-	-	-	-	-
Sector	DB-2	0.80	1/200	2.0	1.7	1.2	-	-	-	-	2	-
	DB-3	2.22	1/340	2.0	1.3	1.0	-	-	-	1	2	-
	DB-4	2.82	1/330	2.0	1.5	0.7	-	1	-	-	2	-
	DB-5	1.80	1/450	2.5	1.5	1.6	-	-	-	-	2	-
	DT-1	3.57	1/460	3.0	1.5	0.7	1	1	-	-	2	-
	DT-2	2.25	1/760	3.0	1.3	1.0	1	1	-	-	-	1
	DT-2'	1.34	1/600	1.0	0.7	1.0	-	-	-	-	-	-
	DT-3	2.87	1/610	3.0	2.5	1.1	1	-	-	-	-	-
	DT-4	1.74	1/690	3.0	1.5	1.0	-	-	-	-	-	-
	DT-5	2.36	1/730	4.0	1.7	1.0	-	-	1	-	-	-
	DT-6	2.25	1/350	1.7	1.1	1.5	-	-	1	-	-	2
	DT-7	1.66	1/360	1.6	1.5	1.0	-	-	1	-	-	-
Sub-total		26.38					3	3	3	1	10	3

Table IV.4 PRINCIPAL CHARACTERISTICS OF SECONDARY DRAINS AND RELATED WORKS (2/2)

Sector	Name	Length (km)	Longi-tudinal Gradient	Dimension /1 (m) B	H	S	Number of Related Structure Drop	Aqua-duct	Siphon	Bridge	Check	Turn-out
Tanima	DT-6'	0.50	1/350	1.7	1.1	1.5	-	-	-	-	-	-
Sector	DT-7'	1.20	1/660	1.6	1.5	1.0	-	-	-	-	-	-
	DT-8	1.00	1/220	1.0	0.7	1.0	-	-	-	-	-	-
	DT-10	1.30	1/250	1.0	1.0	1.5	-	-	-	-	-	-
	DT-11	0.90	1/300	1.0	0.5	1.0	-	-	-	-	-	-
	DT-12	2.30	1/350	1.3	1.0	1.0	-	-	-	-	-	-
Sub-total		7.20					0	0	0	0	0	0
Total		48.51					3	3	3	1	12	2

Remarks: /1: Cross-section is shown as below:

Cross section

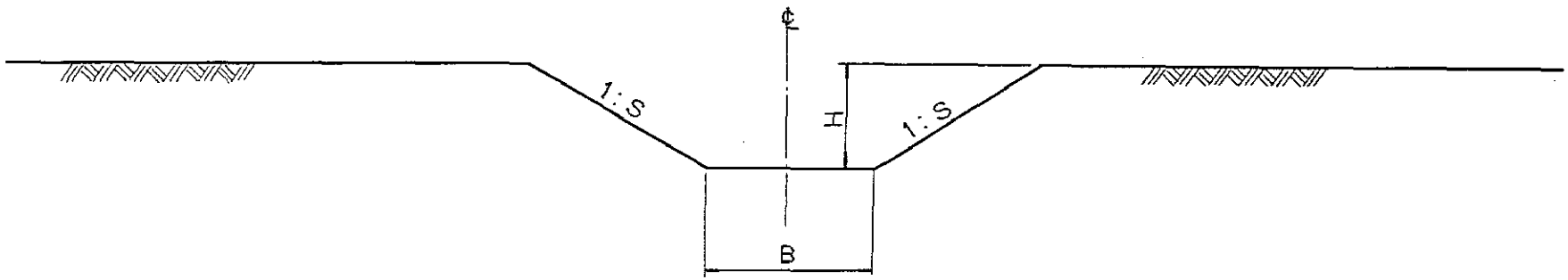


Table IV.5 PRESENT CONDITIONS OF MAIN, SECONDARY IRRIGATION AND DRAINAGE CANALS

(1) Main Canal

Name	Length (km)	Longi-tudinal Gradient	Calculated Discharge (m^3/sec)	Number of Structures						
				Turn-out	Cross Drain	Box Culvert	Gate Spillway	Side Spillway	Gate	Bridge
Sotuba Main Canal	19.0	1/20,000	10.4	11	12	1/2	6/1	1	1	4
Baguineda Main Canal	17.0	1/27,300	6.6	13	8	0	1	1	2	10
Tanima Main Canal	6.1	1/5,600	2.1	3	2	0	0	0	0	1
Total	43.0			27	22	1	7	2	3	15

(2) Secondary Canal

Sector	No. of Secondary Canal	Length (km)	Longi-tudinal Gradient	Calculated Discharge (m^3/sec)	Number of Structures				
					Turn-out	Division Bos w/drop	Check	Drop	Cross Drain
Koba	11	8.9	1/150 - 1/1,000	0.6 - 0.7	130	0	43	1	2
Baguineda	14	19.9	1/220 - 1/2,000	0.7 - 0.9	43	12	1	0	1
Tanima	5	5.8	1/270 - 1/480	0.2 - 0.6	12	0	0	0	0
Total	29	34.6			185	12	44	1	1

(3) Koba Eiver, Fara River and Tanima Main Drain

Sector	Length (km)	Longitudinal Gradient	Calculated Discharge (m^3/sec)	Structures
Koba River	-	-	130	Bridge
Fara River	-	-	23	-
Tanima Main Drain	72	1/750 - 1/1,000	2 - 5	Turnout and culvert

(4) Secondary Drain

Sector	No. of Secondary Drain	Length (km)	Longi-tudinal Gradient	Calculated Discharge (m3/sec)	Number of Structures					
					Drop	Aque-duct	Siphon	Bridge	Check	Turn-out
Koba	11	14.9	1/200 - 1/360	1.2 - 4.0	0	0	0	0	2	0
Baguineda	13	26.4	1/130 - 1/450	2.2 - 5.0	6	6	3	2	22	5
Tanima	6	7.2	1/220 - 1/660	1.0 - 2.0	0	0	0	0	0	0
Total	30	48.5			6	6	3	2	24	5

Remarks: /1: Out of six, two spillways are installed at the Koba crossing point of the Sotuba canal.

/2: This structure is provided to the Sotuba canal at the above-mentioned point.

FIGURE IV - 1 EXISTING SYSTEM OF MAIN IRRIGATION AND DRAINAGE CANALS

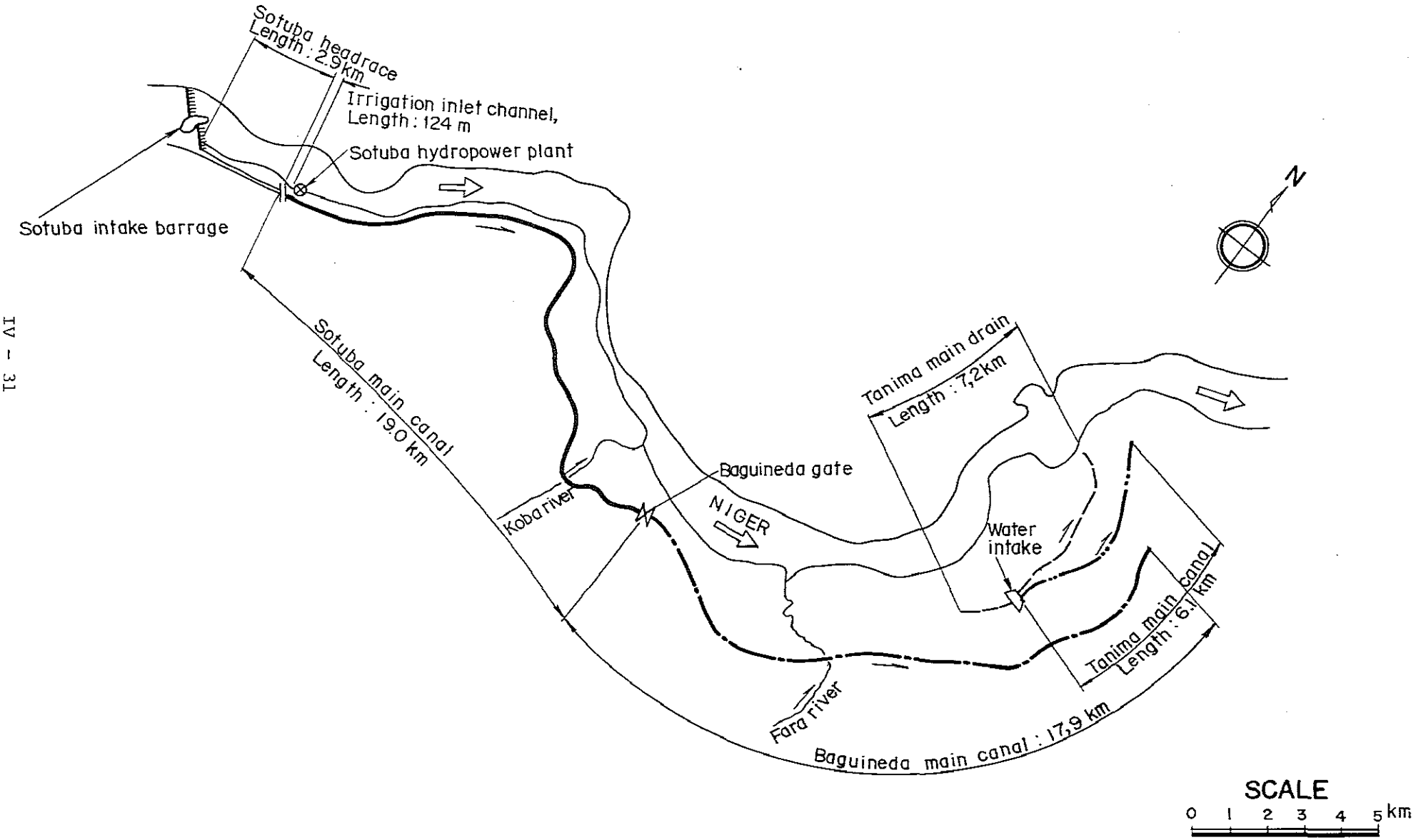


FIGURE IV-2 LOCATION OF EXISTING BRIDGES IN MAIN CANAL

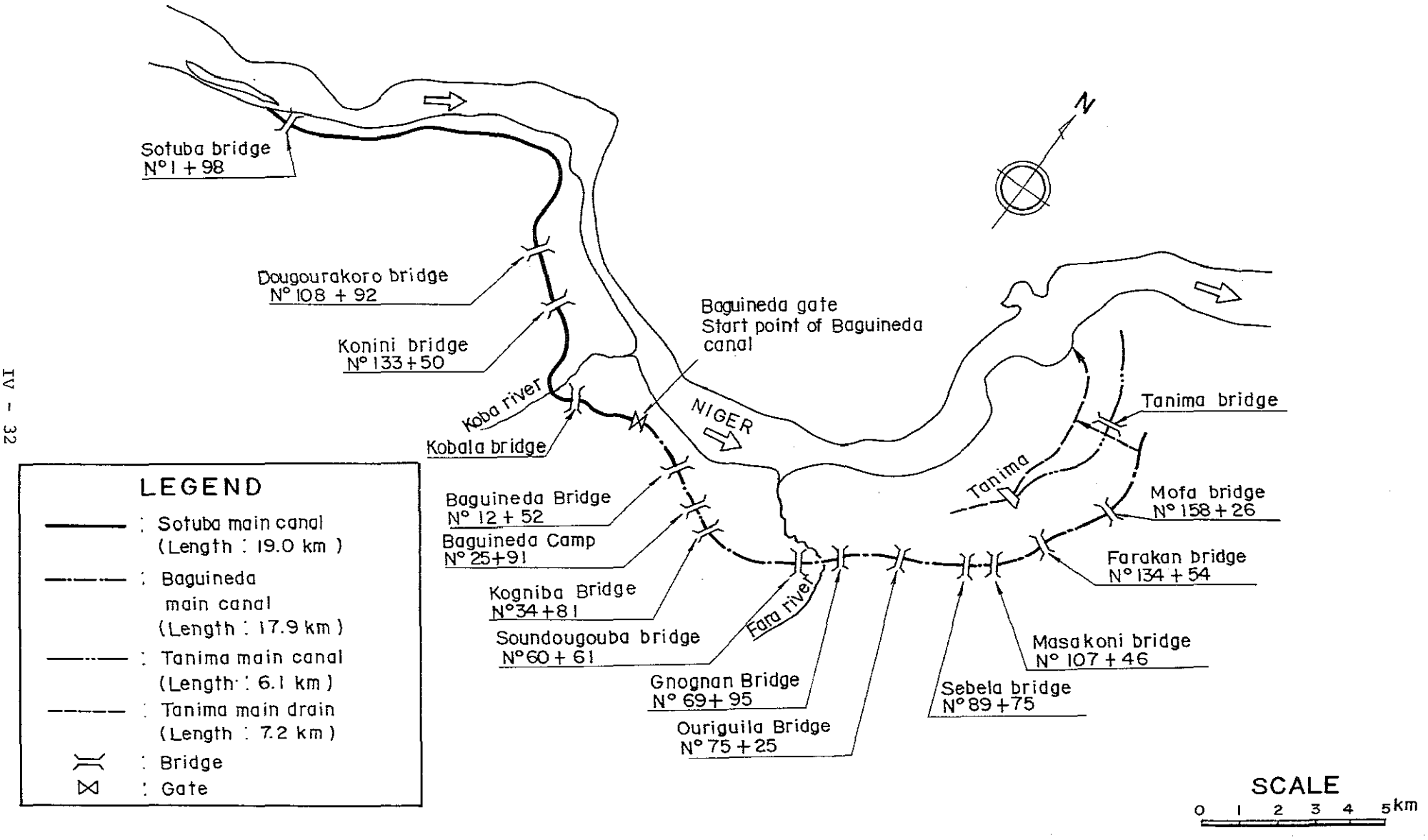
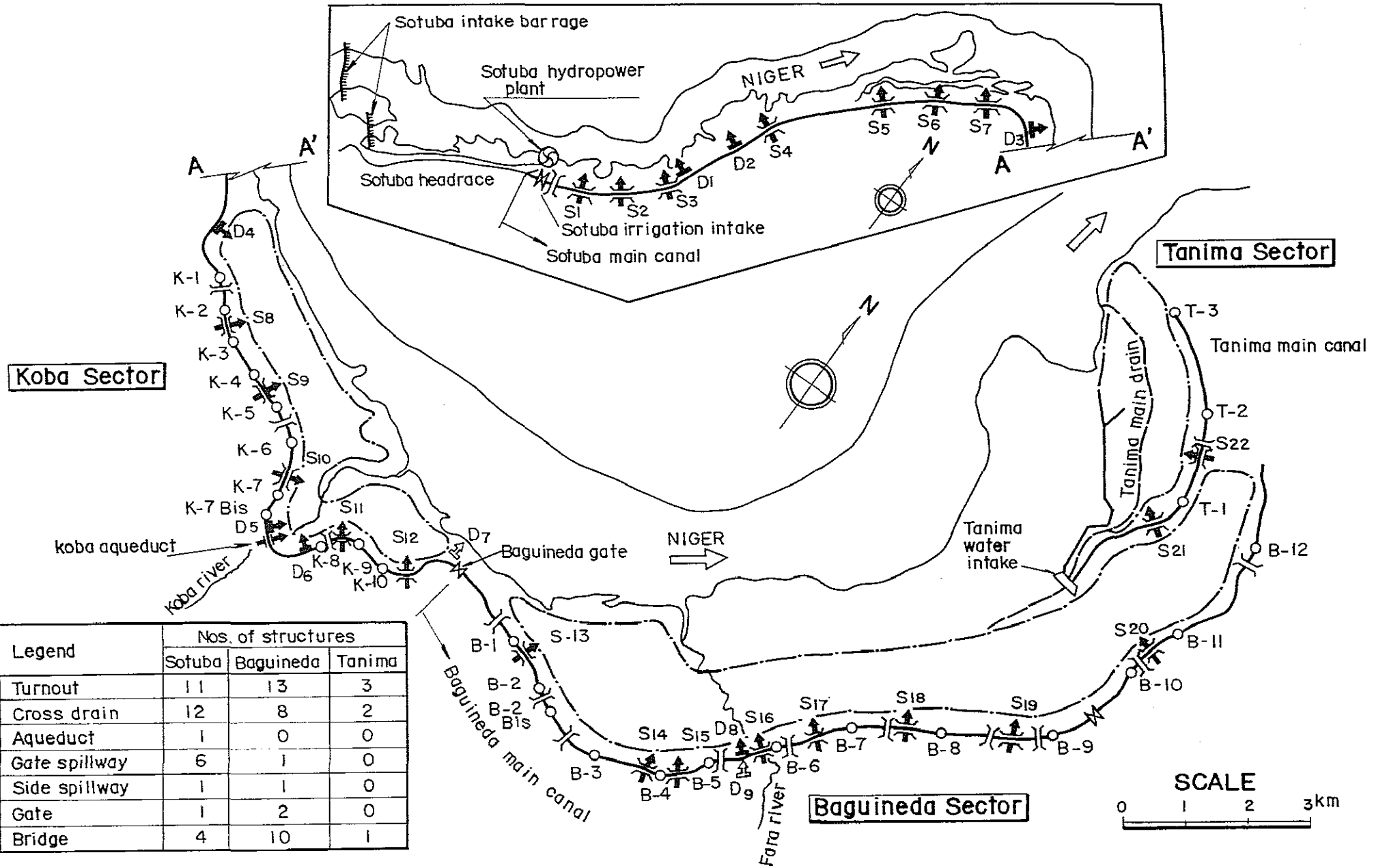


FIGURE IV-3 LOCATION OF STRUCTURES IN MAIN CANAL



Legend		Nos. of structures		
		Sotuba	Baguineda	Tanima
○	Turnout	11	13	3
	Cross drain	12	8	2
	Aqueduct	1	0	0
	Gate spillway	6	1	0
	Side spillway	1	1	0
	Gate	1	2	0
	Bridge	4	10	1

FIGURE IV-4 TYPES OF MAIN CANAL STRUCTURES

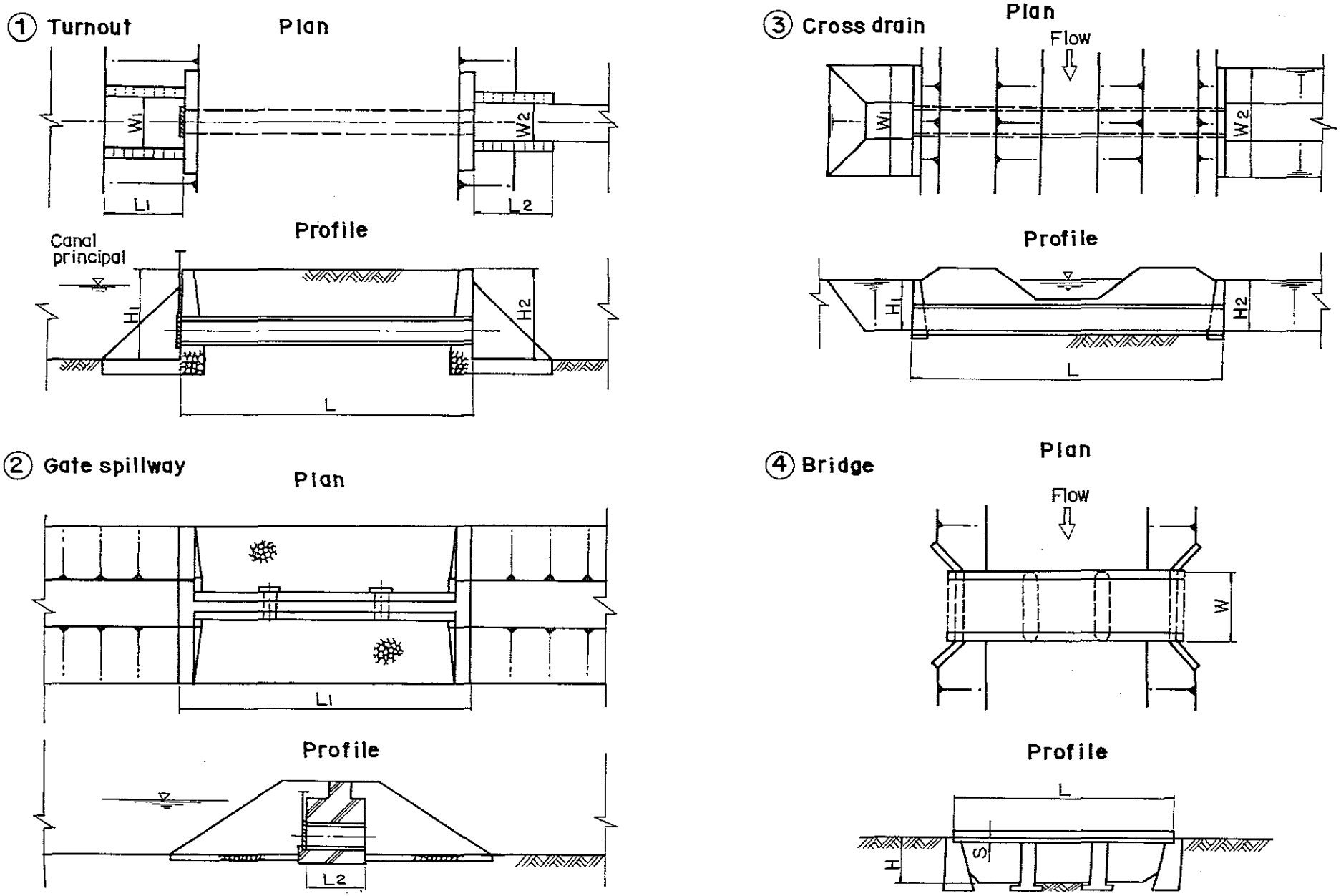
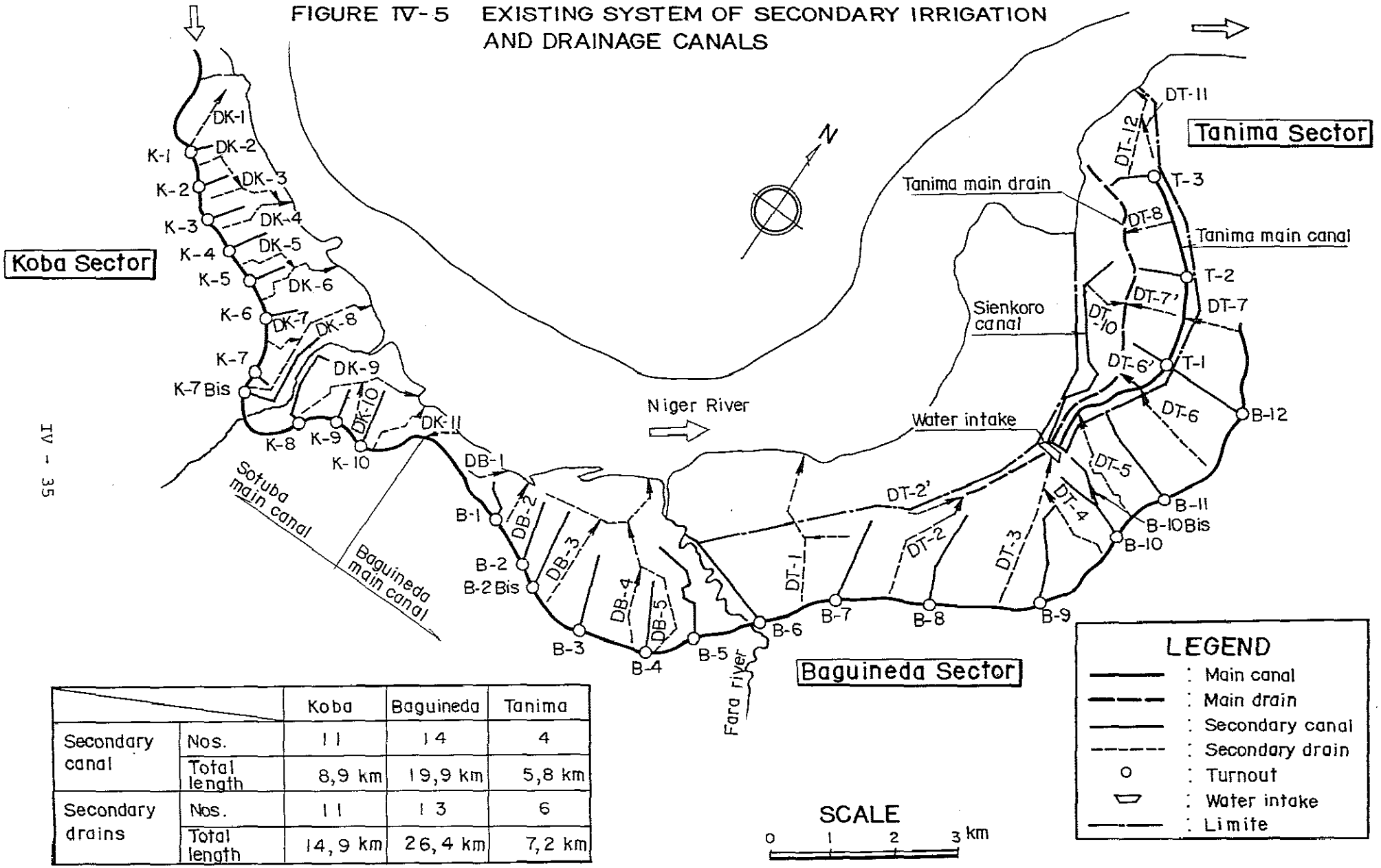
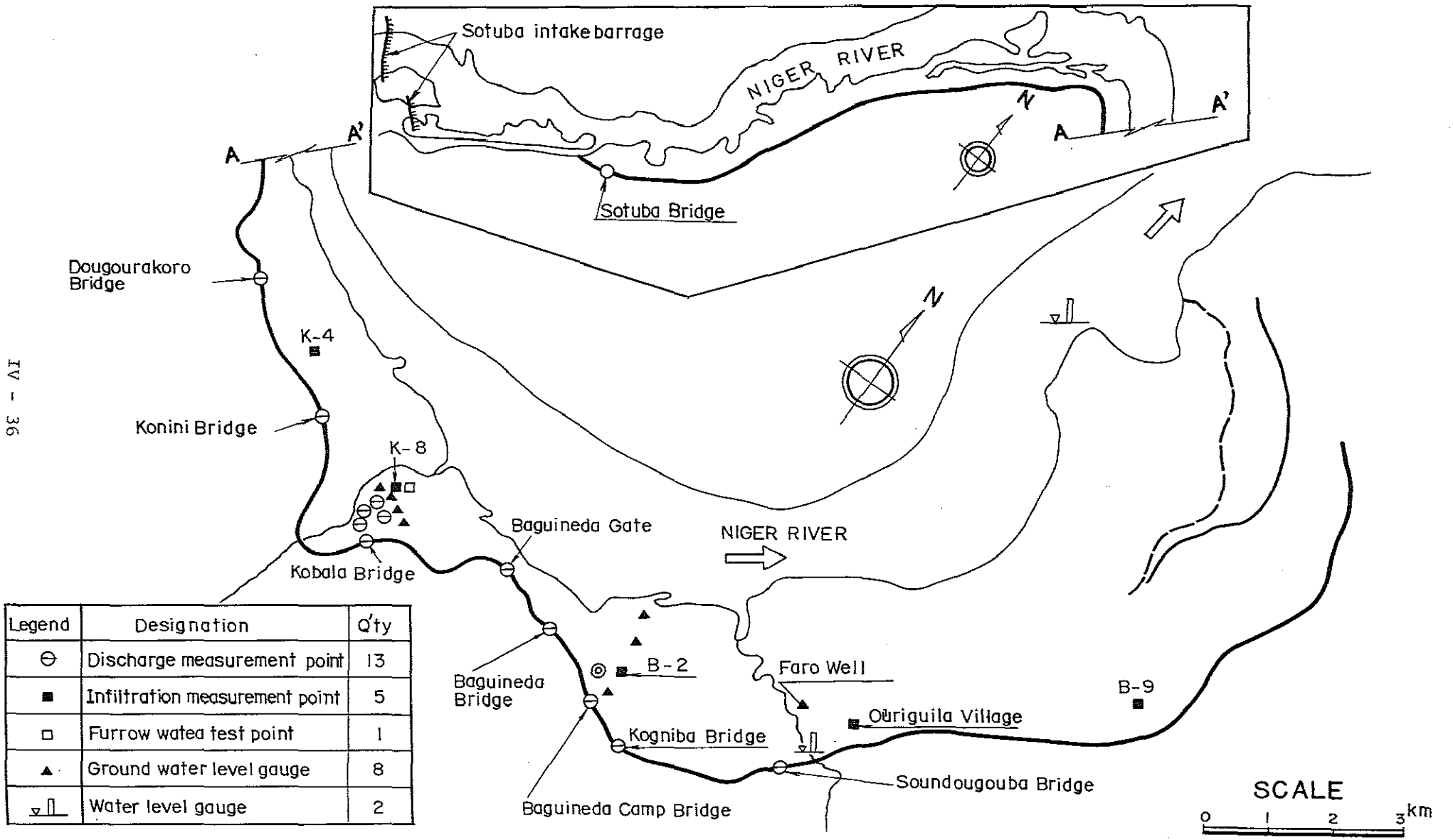


FIGURE IV-5 EXISTING SYSTEM OF SECONDARY IRRIGATION AND DRAINAGE CANALS



		Koba	Baguineda	Tanima
Secondary canal	Nos.	11	14	4
	Total length	8,9 km	19,9 km	5,8 km
Secondary drains	Nos.	11	13	6
	Total length	14,9 km	26,4 km	7,2 km

FIGURE IV-6 LOCATION OF GAUGES AND OBSERVATION POINTS



Legend	Designation	Q'ty
⊖	Discharge measurement point	13
■	Infiltration measurement point	5
□	Furrow watea test point	1
▲	Ground water level gauge	8
▽	Water level gauge	2

ANNEX V

AGRICULTURAL DEVELOPMENT PLAN

ANNEX V

AGRICULTURAL DEVELOPMENT PLAN

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AGRICULTURAL DEVELOPMENT PLAN

V.1 Basic Concept for Agricultural Development

V.1.1 Constraints and prospects

The project area had been developed for rice cultivation during the period from 1930 to 1959. It has a total irrigation area of 3,000 ha. Although the area is highly suitable for intensive irrigation farming, the crop planted area had been decreasing progressively and only 1,000 ha were being planted with cereals and vegetables in 1984. On the other hand, the remarkable recovery in the planted area can be recognized under much rainfall in this year, 1985. This fact implys that the planted area could be extended if major constraints would be eliminated in future.

In view of the present agricultural conditions, the following may be considered as main constraints against the present agriculture in the project area.

(1) Decrease of canal discharge in the dry season as a result of installation of hydro-power plant at Sotuba.

(2) Important water loss due to leakage problem of the existing irrigation facilities.

(3) Incompleteness of various rehabilitation works carried out so far.

(4) Inadequate management and maintenance of irrigation systems.

The project area is, however, blessed with a favourable situation with good prospects for agricultural development project as explained below;

(1) The area is located in the proximity of the capital city which is large market of farm products and has means of exporting products to foreign countries,

(2) The existing agro-industrial factories are large enough to receive raw materials which will be produced in the project area.

(3) The farmers will be fully supported by the Baguineda Operation in terms of acquisition of farm inputs and trade of products.

(4) The completion of the Selingue Dam in 1981 ensures more stable irrigation water supply.

(5) The prevention of leakage in irrigation canals and facilities will enable to realize double cropping under the year-round irrigation.

V.1.2 Basic concept for agricultural development

The Government of Mali gives a high priority to agricultural development aimed at the following objectives;

(1) Increase of cereals production in order to cover the total demand in the country,

(2) Increase of industrial crop production by means of crop diversification under valorization

(3) Supply of raw farm products to processing factories,

(4) Export of excess products in order to contribute to financial recovery and also to promote the augmentation of agricultural production, and

(5) Increase of dairy products in order to supply protein diet.

In line with the government policy, the Baguineda Operation has formulated the development plan of the project area which focuses on;

(1) Increase of vegetable production for both local processing and export.

(2) Increase of milk production in order to supply raw milk to ULB in a quantity of 6,000 lit. per day.

(3) Introduction of smallholder farming instead of tenant system in farm management.

Judging from the potentialities and the priviledged situation of the project area, the Baguineda Agricultural Development Project will be able to attain a part of the goals envisaged by the Government and the Baguineda Operation. Under these circumstances, the basic concept is worked out as follows:

(a) Crop production plan

This plan aims;

- to increase cereals production by intensive farming under the year-round irrigation which enables to cultivate two crops, i.e. cereals and vegetables, per annum,
- to supply tomatoes to SOCAM for processing, in line with the government policy,
- to increase production of export crops such as French beans.

(b) Livestock production plan

The main objective of this plan is

- to increase milk production for supplying the raw milk to ULB.

V.1.3 *Selection of crops*

With a view to formulating an optimum land use and a proposed cropping pattern, crops are selected on the basis of demand forcast, profitability and intension of farmers. As a result, the following crops are selected as the most suitable ones for the Project.

(1) Paddy

Paddy would constitute the main crop in the project area. As mentioned in Section V.5.1, the shortage of rice is gradually increasing and would attain 169,000 t in the year 1995, which corresponds to 20% of total shortage of cereals.

According to crop profitability presented in Section XI.4, rice shows the highest value among the cereal crops.

It is to be noted also that rice had been planted as a main crop in the project area under the management of the Niger Office from 1930 to 1959. Therefore, rice farming practices are rather familiar to local farmers and, technically speaking, there would be no difficulty to introduce rice cultivation on a large scale in the area.

(2) Maize, sorghum and millet

Maize, sorghum and millet are stable foods as important as rice for the people of Mali. The shortage of these cereals would reach 662,000 t in 1995. As to profitability they are less profitable than rice, but the people of Mali prefer to produce them. For economical reason, therefore, maize, sorghum and millet would be introduced only for home-consumption of local farmers in the area.

(3) Tomato

Tomato would be cultivated in the project area as a raw material to be supplied to SOCAM, which is in serious shortage of tomato for processing. SOCAM plans to collect 3,000 t of tomato per annum.

(4) French beans

Export of vegetables and fruits is important activity for Mali in order to earn foreign currency. Until the beginning of 1980s, sweet peppar and French beans have been extensively planted and exported to European countries and the Middle East. Over last few years, Mali has lost these foreign markets for sweet peppar in competition with Morocco and Canary Islands which locate more closely to the said markets than Mali. Consequently, sweet pepper is not produced in the project area anymore.

On the other hand, the demand of French beans are increasing progressively. According to FRUITEMA, French beans are still much promising crop for exporting. FRUITEMA is planning to export about 200 to 400 t of French beans per annum.

With regard to profitability, French beans are quite profitable as well as other vegetables. It is to be added also that there already exist conditioning and sorting facilities for French beans in the area.

(5) Other vegetables and oil crops

In addition to the above mentioned products, other vegetables and oil crops such as onion, watermelon, okra, potato and groundnuts are also envisaged for introduction in the project area. These crops are, at present, more or less planted in the area and sold in the markets of Baguineda.

At present, the large portion of vegetables sold in Bamako comes from the areas in the vicinity of Bamako. As the production capacity of these areas seems to have attained to the ceiling amount, the growing demand of vegetables would exceed the supply in near future. The Project is, therefore, expected to make up their deficit.

Oil crops such as peanuts would be introduced only for home-consumption of farmers in the project area.

(6) Fodder crops

Fodder crops would be introduced in the project area for the purpose of milk-cow raising. In order to meet the protein demand in Bamako, ULB has been expanding the processing capacity of dairy products.

Taking such situation into consideration, the Project is expected to involve the livestock development for producing raw milk to be received by the ULB plant. For obtaining raw milk of high quality, the modernized livestock development would be introduced, i.e. artificial insemination, conditioning facilities of fresh milk etc. In addition, the fodder crops of high quality would be produced under irrigated condition.

The meat production is excluded from the present plan for the reason that meat productivity of cattle is low as compared to milk.

V.2 Proposed Land Use

V.2.1 Irrigation area

Taking into account the soil and topographic conditions, the suitable land for irrigation development is estimated to be 3,520 ha in total. After deduction of some areas required for construction of infrastructures, i.e. canals, roads, etc., the total net irrigable land would be 3,000 ha.

Upon completion of new irrigation and drainage system, road network, etc., this proposed area of 3,000 ha would become irrigable and intensive land use can be achieved with the introduction of modern irrigated farming techniques.

V.2.2 Proposed land use

In order to determine the optimum method of land use in the project area, a demand projection was made on the basis of future deficit of cereals and processing capacity of agro-industrial facilities. In this context, the deficit is equivalent to the difference between total demand and anticiaped production in the nation. Besides, the planted area required to meet all or part of the future deficit is calculated for each crop. The study results are summarized below.

Proposed Crop	Shortage or Processing Capacity (t)	Anticipated Crop Yield (t/ha)	Planted Area Required (ha)
	(1)	(2)	(1)/(2)
Paddy	260,000/1	4.0	65,000
Maize, sorghum and millet	662,000/1	2.5	264,800
Tomato	8,100/2	25.0	350
French beans	400	2.0	200
Other vegetables	6,240	10.7/3	580
Fodder crops	20,000 lit.	22.5 lit./day/ha	890

Remarks: /1: Shortage is estimated to be the balance between demand and production in the nation.
/2: Processing capacity of SOCAM.
/3: Average yield of common vegetables in Mali.

The estimation of anticipated crop yield and milk production per hectare are explained in Sections V.3.5 and V.4.2 respectively. Details of the demands for paddy, maize, sorghum, millet, tomato and French beans are explained in Section V.5. The demands of other vegetables and oil crops are estimated on the following basis;

i) Increase in population of Bamako City from 1985 to 1995: 190,000

ii) Population of the project area: 2,170 households x 8.1 persons/household = 18,000

iii) Per capita consumption: 30 kg/year

iv) Demand forecast for 1995: 30 kg x (190,000 + 18,000) = 6,240 t

In addition, a profitability evaluation is made on each of the crops proposed for the Project. It may be noted that the net return of each crop is analyzed through calculation of the balance of the gross production value and crop production cost. The values obtained are:

(Unit: 10^3 F CFA/ha)

Proposed Crop	Gross Production Value	Crop Production Cost	Net Return
Rice	530	197	333
Maize	372	142	230
Sorghum & Millet	369	114	255
Tomato	1,875	370	1,505
French beans	1,410	249	1,161
Onion	2,150	343	1,807
Potato	1,000	442	558
Watermelon	1,200	279	921
Okra	668	181	487
Groundnuts	345	134	211

According to the evaluation, vegetables are quite profitable. As a result of recent price decrease of cereals in international markets, cereal crops are commercially less profitable than vegetables. However, high priority is placed in the food production as a national policy. That encourages us to propose the production of staple food crop for the Project.

Based on the above studies, the land use plan proposed in the last feasibility study is concluded to be basically sound and applicable in the present study. Only sweet peppar is replaced by other vegetables. The following table presents the proposed land use pattern.

(Unit: ha)

Proposed Crops	Rainy Season	Dry Season	Total Area
Paddy	2,400	-	2,400
Maize	-	1,600	1,600
Sorghum & millet	-	200	200
French beans	-	100	100
Tomato	-	350	350
Onion	-	150	150
Others	200	200	400
Fodder crop	400	400	800
Total	3,000	3,000	6,000

With an aim to use the irrigable land in the most profitable and rational manner, it is planned that the planting areas of vegetables with high return will be as large as possible. Rice and other cereals would be planted in the remaining area. For reasons of the economical use of irrigation water and considering the climatic conditions in the project area, it is planned to cultivate paddy in the rainy season and other cereals in the dry season.

According to the results of soil survey, it can be judged that almost all soils are suitable for the proposed crops. This enables to apply the same cropping pattern evenly, except for fodder crops, in the whole area.

V.3 Crop Production Plan

V.3.1 Proposed cropping pattern

For preparation of a suitable cropping pattern, first of all, the relationship between physiological characteristics of crop and the climatic conditions in the project area is studied as mentioned below;

(1) Sunshine duration

In order to increase the yield of crops, especially cereal crops, great attention should be paid to their photosynthetic properties which are considerably influenced by sunshine. Based on the physiological characteristics of the cereals, cropping pattern should be so determined that their growth period coincides with the season in which the daily sunshine duration is long enough.

(2) Air temperature

With respect to plant physiological characteristics of rice, a fall in air temperature to less than 17°C during the stages of spikelet differentiation, reduction division and flowering have an unfavourable influence on its yield. The cropping pattern for the rice plant should, therefore, be prepared in such a manner that the said stages will not fall within the period of low temperature from the beginning of December to the beginning of February.

In addition to the study on climatic conditions, consideration was made on the most suitable period for exportation of French beans and on economical use of irrigation water. The said crop would be mainly exported to European countries during the period from the end of December to the end of March which coincides with the preharvest stage in these countries. Therefore, the harvest and export of French beans should be carried out in this period.

Besides, water requirement for rice cultivation is generally higher than that for other crops. Therefore, in order to enable a rational use of irrigation water, the cropping pattern will have to be so determined that the high water requirement stage during the growth period of rice plants does not fall within the dry season.

Based on these studies and consideration, the proposed cropping pattern is set up as shown in Fig. V.1.

V.3.2 Selection of varieties

For maximizing the crop productivities, high yielding varieties are to be introduced to replace the local varieties as much as possible. In selection of suitable varieties, attention should be paid particularly to the varieties which are remarkably tolerant of pest and plant disease. Although the final selection of suitable varieties will have to be made through experiments and variety trials, the following varieties can be recommended.

Crops	Recommendable Varieties
Rice	BG 90-2, H 15-23 DA, IRAT 144
Maize	Tlaltizapan 7842, IRAT 100
Sorghum	SB 742-22, IRAT 204, L30
Millet	IRAT P1, IBY 8004, IBY 8001
Tomato	ROSSOL, UC 82, NAPOLI
French beans	Monel
Onion	Texas Early Grans
Potato	Arran Bannen, Ackersegen
Watermelon	Klondike
Okura	Lrimson Spineless
Groundnuts	59-127, 20-206

The varieties of rice, other cereals and groundnuts are selected on the results of field experiments conducted by SRCVO. The varieties of tomato and French beans are selected on the basis of information given by SOCAM and FRUITEMA respectively. On the other hand, the varieties of others are picked from the "Mémento de l'Agronome" published by "Ministere de la Coopération de la Republique Française", which is widely referred to for agricultural development in African countries.

V.3.3 Proposed farming practices

The most practical farming pactices are studied for exploitation of the potential productivities of crops. For this study, the prevailing farming practices in the project area and the technical level of local farmers are taken into consideration.

The proposed farming practices based on the above study are explained below and their details are shown in Tables V.1 to V.10.

(1) Land preparation

Land preparation for the proposed crops would be carried out by animal power. The land will firstly be ploughed and harrowed twice over to ensure stabilization of the rooting of seedlings and irrigation operations. These practices would be done with plough and tooth harrow.

As for rice, soil puddling and land leveling works would be required after harrowing so as to ensure even distribution of irrigation water and to facilitate weeding. Puddling and leveling works would be carried out under flooded condition by using puddling rake and level board.

(2) Seeding

Two seeding methods are proposed to be adopted in the project area. The first method is to prepare the seedlings in nursery beds and transport them later in the fields. This method would be applied for rice and vegetables except for watermelon and potato.

In case of rice, seedlings would be prepared by sowing the seeds at the rate of 30 kg for each hectare of main field, on 400 m^2 of nursery bed for 20 days. Prior to seeding, it is necessary to treat the seeds with agro-chemicals in order to protect the rice plants from diseases and to facilitate their normal sprouting. The seedlings would then be transplanted in the fields by usual planting practice with spacing of 15 cm x 30 cm or by hills of 2 to 3 seedling each.

In case of vegetables, seedlings would be grown first in small shady beds and transplanted later in nursery bed with suitable spacing. Actual transplanting to the fields would be made 30 days after seeding by usual planting practice with following spacing and plant density.

Crops	Furrow (cm)	Row (cm)	Plant Density (nos./ha)
Tomato	120	45	18,000
French beans	60	30	55,000
Onion	30	10	330,000
Okra	150	40	16,700

The second method is to sow the seeds directly in the fields. This method would be applied to such crops as maize, sorghum, millet, groundnuts watermelon and potato. The recommended seeding spacing and plant density would be as follows:

Crops	Furrow (cm)	Row (cm)	Plant Density (nos./ha)
Maize	80	25	50,000
Sorghum	80	25	50,000
Millet	80	25	50,000
Groundnuts	60	15	110,000
Watermelon	240	180	2,300
Potato	60	30	55,000

In the direct seeding method, thinning would be required after establishing of the seedlings. All the seeding, transplanting and thinning operations would be carried out by hand. The required quantities of seeds per hectare of proposed crops are shown in Table V.11.

(3) Fertilization

Application of chemical fertilizer would be essential for attaining the anticipated crop yield. Based on the results of a study on soil characteristics carried out by the Yugoslavian survey team in 1962, the fertilizer requirements for each crop are determined as presented in Table V.11.

Prior to harrowing a basic application of fertilizer should be made to prepare a fertile soil foundation for the seedlings. This application would be made by hand using about 1/3 to 1/5 of the total requirement of fertilizer.

As for top-dressing, the split-application method is recommended in order to ensure smooth growing of the plants.

(4) Plant protection

For the purpose of protecting the plants against insects and diseases, rational application of agro-chemicals would be required. It is to be noted that crop damages by insects and diseases are not serious so far, in spite of the lack of plant protective measures, because the farmers are cultivating local varieties which are tolerant of diseases. However, when the high yielding varieties will be introduced, it would be indispensable to apply agro-chemicals.

Considering the life-cycle of insects and growing stages of the crops, suitable dosage of chemicals to be estimated as presented in Table V.11. The knapsack-type sprayer could be used for application of these chemicals in the field. In order to obtain good results, it is recommended that the above-mentioned plant protection works will be carried out in a systematic way by the farmers' associations.

(5) Weeding

Weeding is one of the essential works to be done according to the proposed farming practices for crop protection. After seeding and transplanting, weeding would be carried out two or three times, depending on the conditions of the weed growth. In order to execute the weeding efficiently, it is planned to use rotary weeders for rice cultivation and traditional hoes for other crops.

(6) Harvesting

In the proposed farming plan, the harvesting is planned to be carried out manually by work force of farmers. However, with a view of improving the quality of marketable crops, it would be preferable to adopt modern mechanized threshing method for the improved varieties of paddy and maize. It is proposed, therefore, to introduce pedal thresher for rice and corn sheller.

V.3.4 Farm labour and machinery requirements

(1) Farm labour requirement

The labour requirement for different crops proposed in the crop production plan is estimated as shown in Table V.12. According to this estimation, the monthly labour requirement for a 1.2 ha typical farm is presented in Table V.14, of which summary is given below:

Month	Monthly Labour Requirement (Man-day)	Available Labour Force (Man-day)
Jan.	1.8	4.2
Feb.	1.6	4.2
Mar.	1.2	4.2
Apr.	1.3	4.2
May	2.5	4.2
Jun.	2.9	4.2
Jul.	2.2	4.2
Aug.	1.6	4.2
Sept.	1.8	4.2
Oct.	2.1	4.2
Nov.	2.1	4.2
Dec.	1.8	4.2

As shown in the above table, the peak labour requirement would occur in June corresponding to the transplanting period of paddy under the proposed cropping pattern. The work force per household is to be 4.2 persons as mentioned in section III.3.2. As a result, the estimated peak labour requirement of 2.9 man-days would be sufficiently met by the family work force. In addition, each family has enough man power for cultivating his land outside the irrigation area.

The animal power requirement for each crop is estimated as shown in Table V.13, and the monthly animal power requirement for a 1.2 ha typical farm is calculated as shown in Table V.14 and summarized below;

Month	Monthly Animal Power Requirement (hr/day)	Available Animal Power (hr/day)
Jan.	0.6	3.0
Feb.	0.3	3.0
Mar.	0.3	3.0
Apr.	0.4	3.0
May	1.6	3.0
Jun.	2.5	3.0
Jul.	0.9	3.0
Aug.	0.2	3.0
Sept.	0.3	3.0
Oct.	0.7	3.0
Nov.	1.1	3.0
Dec.	1.7	3.0

It is proposed that each farm household in the project area owns two working oxen for farming. It can be assumed that the available animal power per household would be 3.0 hr/day.

V.3.5 Anticipated crop yield and production

(1) Anticipated crop yield

In the case of "with" project, crop yields of cereals and groundnuts are estimated on the basis of the results of trial cultivations and varietal tests conducted by SRCVO. The yield of tomato is estimated on the basis of the experimental result given by SOCAM. As for other vegetables, the availability of information from previous studies in the project area enables us to anticipate the crop yields. The study results are shown below:

Crop	Anticipated Yield (t/ha)
Paddy	4.0
Maize	3.0
Sorghum	3.0
Millet	3.0
Tomato	25.0
French beans	2.0
Onion	25.0
Potato	8.0
Watermelon	20.0
Okra	4.0
Groundnuts	1.5

In the case of "without" project, the low crop yields will continue until the leakage problem of the existing canals will be eliminated. It is estimated that yields of crops in the project area will remain unchanged in the future. The crop yields in the case "without" project are estimated as follows:

Crop	Yield (t/ha)
Paddy	1.4
Maize	1.1
Sorghum	0.7
Millet	0.7
Tomato	11.8
Onion	21.4
Groundnuts	0.6

(2) Anticipated crop production

Based on the crop yields discussed above, the anticipated crop production in the cases of "with" and "without" project are estimated as presented in Table V.15, and are summarized below:

Crop	With Project		Without Project		Increase in Production (t)
	Yield (t/ha)	Production (t)	Yield (t/ha)	Production (t)	
Paddy	4.0	9,600	1.4	390	9,210
Maize	3.0	4,800	1.1	240	4,560
Sorghum & Millet	2.0	400	0.7	160	240
French beans	2.0	300	-	-	300
Tomato	25.0	8,750	11.8	1,770	6,980
Onion	25.0	2,500	21.5	1,720	780
Potato	8.0	800	-	-	800
Watermelon	20.0	2,000	-	-	2,000
Okra	4.0	400	-	-	400
Groundnuts	1.5	150	0.6	10	150

The yields of crops would increase gradually in parallel with the farmers' accumulation of experience and knowledge on irrigated cultivation and with the increase in land productivity. It is expected that anticipated yields can be attained from the 5th year after the completion of the irrigation facilities.

V.3.6 Processing facilities

The facilities required for the envisaged agricultural development would include rice mills, conditioning and sorting facilities for French beans and a tomato processing factory. Other crops such as maize, sorghum, onion, watermelon, etc. would not need treatment facilities as they will be marketed in their natural condition for consumption.

It is expected that with the completion of the Project, about 9,600 t of paddy will be produced annually. As at present there is no rice mill in and around the project area, it will be necessary to install new rice mills within the project area.

Design conditions and main features of the proposed rice mills would be as described below and their typical layout is illustrated in Fig. V.2.

- Milling system : One-pass system consisting of only one machine for all the processed of husking, separation of husk and brown rice, whitening and bran removal
- Milling capacity : 600 kg per hour
- Milling efficiency : 65%
- Required power : 18 ps
- Building area : 50 m^2

It is estimated that a total of 13 rice mills would be required for the Project, based on the following details:

a)	Annual paddy production	:	9,600 t
b)	Number of working days of rice mill (6 months x 25 days per month x operation efficiency rate of 80%)	:	120 days
c)	Working hours per day (2-shift operation)	:	10 hours
d)	Total working hours per year ((b) x (c))	:	1,200 hours
e)	Required processing capacity of paddy per working hour (a)/(d)	:	8 t/hour
f)	Milling capacity per rice mill	:	0.6 t/hour
g)	Required number of rice mills ((e)/(f))	:	13 nos.

Taking into consideration the road condition in the project area, it is planned that the rice mills will be beated in the following villages.

a) Dougourakoro
b) Konini
c) Kobala
d) Baguineda camp
e) Gnogna
f) Sebela
g) Massakoni
h) Kokoun
i) Farakan
j) Palasso
k) Mofa
l) Sienkoro
m) Tanima

The operation and maintenance of each of the rice mills would be undertaken by the Baguineda Operation. The fuel, labour and materials required for rice mill operations are estimated as shown in the following table.

Items	Q'ty required for Each Rice Mill	Total
a) Gasoline (k lit.)	2.4	31.2
b) Operator (person)	2	26
c) Seasonal labour (man-day)	1,200	15,600
d) Jute bags (50 kg)	9,600	124,800

The annual production of tomato and French beans in the project area would be 8,750 t and 200 t respectively. Out of the total production of tomato, 8,100 t would be sold to SOCAM as raw material for processing, and the remaining 650 t would be supplied to the markets or consumed by farmers. All the French beans produced in the project area would be sold to FRUITEMA for export.

Processing of tomato and sorting of French beans would be carried out in the existing facilities of SOCAM and FRUITEMA. It is considered that these facilities have enough capacity to process the anticipated quantities of the above-mentioned products as shown below.

Facilities	Production (t)	Operation Days (days)	Required Capacity (t/day)	Existing Capacity (t/day)
SOCAM				
- Tomato processing factory	8,100	135	60	60
FRUITEMA				
- Conditioning and sorting factories for French beans	200	88	2.3	2.5/1

Remarks: /1: 0.35 t/hr x 7 hr/day = 2.5 t/day

V.4 Livestock Production Plan

V.4.1 General

Due to the severe drought in 1972 - 1973, the cattle number in Mali estimated to be about 5.4 million in 1971 was abruptly reduced to 3.6 million in 1974. To cope with this critical situation, the Government of Mali decided to give high priority to cattle production in its 1974 - 1978 Five-Year Plan in order to make up for the cattle loss. As a result, the cattle number in 1979 rose to 4.8 million, which was lower than that before the drought but the cattle production is still increasing.

On the other hand, as it is said in section V.1.2, the Baguineda Operation has a long-term plan to produce 6,000 lit. of milk per day for feeding ULB and for covering local demand.

The ULB milk plant is located at Sotuba and its processing capacity is about 30,000 lit./day. The average milk production in recent 3 years from 1982 to 1984 was about 17,500 lit./day. As mentioned in section III.4, ULB envisages to increase milk production to the level of 50,000 lit./day by 1987, but it has actually no plan for additional milk collecting. The raw milk which can be collected from the farms in the vicinity of the ULB Plant is mostly for self-consumption and the marketable volume is in fact negligible. During the period from 1970 to 1984, the daily collection of raw milk averaged only 481 lit. and there was even a tendency of decrease (See Table V.16). From this fact, it was judged that after completion of the plant extension work in 1987, ULB would face a lack of about 32,500 lit./day of raw milk.

Considering the present condition of livestock production, the development policy of the Baguineda Operation and the ULB extension plan, livestock development is proposed to be included in the Baguineda Agricultural Development Project, aiming mainly at milk production for supply to the ULB plant.

As mentioned in section V.1.2 and V.1.3, the livestock development plan is worked out as outlined below:

(1) The dairy farm would be operated under direct control of the Baguineda Operation. As the planned rather intensive dairy farming will require quality control and prompt processing of collected milk as well as expensive farm facilities, artificial insemination, etc., it would be indispensable to introduce the modern ranching practice so as to ensure smooth carrying out of relatively complex and costly farm operations.

For the above reason, it would be recommendable that the dairy farm will be operated under public management and not by the farmers.

(2) The objective of dairy farming would be to produce 9,000 lit./day of milk, i.e. 28% of the volume of 32,500 lit./day additionally required after extension of the ULB plant. In fact, the profitability of dairy farming would be lower than that of cereal and vegetable crops. Taking this low profitability and the role of the Baguineda Operation into consideration, the pasture area is reduced to the limit of requirement for production of 9,000 lit. of raw milk in minimum per day. This volume is substantially larger than the production of 6,000 lit./day envisaged in the long-term plan of the Baguineda Operation.

V.4.2 Dairy farming

(1) Milk production and breed selection

The local cattle breeds in Mali have not high milk productivity. Therefore, genetic improvement by cross-breeding to local species with highly productive species would be required. Two following methods are considered for breed improvement:

(a) Cross-breeding of N'dama species, which is highly tolerant to hot and humid climatic condition and tropical diseases, with highly productive species such as Jersey, etc. to produce cross-bred milk-cows.

(b) Introduction of pure-bred species such as Jersey, black piebald Frisonne, etc.

In the first case, milk production of Jersey x N'dama half-bred milk-cows would be of course lower than that of pure-bred milk-cows. Moreover, multiplication of improved milk-cows by cross-breeding would take 15 - 20 years or more. From the viewpoint of productivity and profitability, therefore, the first method is not feasible.

On the other hand, however, application of the second method would require the introduction of highly productive species, and it will be necessary to take into consideration the pathological and climatic problems facing the introduced breeds. For this reason, it is planned that the dairy farm will be operated by the Government.

Furthermore, introduction of intensive dairy farming in a tropical area could be realized only if the following fundamental operations are satisfactorily carried out:

- Feeding
- Breed selection
- Construction of cattle-sheds

Only a well-equipped state farm would be able to undertake efficiently the above-mentioned operations.

For the aforesaid reasons, it was recommended to adopt the method (b) and to introduce the Jersey breed which is suitable to the tropical climate. The breeding cattle should preferably be imported from hot countries with climatic conditions similar to those in Baguineda.

The introduction of milk-cows would be carried out in accordance with the progress of works, as shown in Table V.17. 840 head would be introduced from the 3rd to the 5th year after commencement of works. It was presumed that about 180 head, i.e. 20% of the number of introduced cows, would die due to non adaptation to tropical condition.

The reproduction of milk-cows from the remaining 660 head would continue until reaching a total of 2,140 head. At that time, the farm would be able to produce 9,000 lit. of milk per day as projected. This production can be attained only from the 7th year after introduction of milk-cows or from the 9th year after commencement of works.

(2) Milk herd raising

The stock farming techniques proposed for milk herd raising are described below by referring to the documents from the "Centre National de Recherches Zootechniques (Sotuba)" and the "Mémento de l'Agronome" published by "Ministére de la Coopération de la République Française".

(a) Raising method: Stabling

This intensive raising method would enable optimum use of pasture land and facilitate milking operation. Other advantages would include excellent sanitary control and total elimination of external and internal parasites.

(b) Milking method: Milking would be made manually twice a day. A milker would be required for every two cows.

(c) Reproduction: The cows of over 24 months would be artificially inseminated four times in maximum. The period between calvings was estimated to be 15 months. In case of non gravidity after the 4th insemination, the sterile cows would be discarded. The sterility rate was estimated to be 5%.

(d) Age of discharge: After the 6th calving, the cows would be discharged and sold to slaughter.

(e) Death rates: Death rates were estimated to be 5% respectively during the nursing and growth periods.

(f) Sanitary measures: The newly introduced cows would be dipped in parasiticidal solution for prevention against scabies and cattle-tick, etc. Disinfection of the cows by application of insecticides would be made at least twice a year.

A series of health cares, especially various vaccinations, would be given in accordance with a tight prophylactic program. Vaccines against cattle-plague, peripneumonia, anthrax, etc. would be provided by the "Laboratoire Central Vétérinaire".

(g) Nursing of calves: Calves would be upper-fed. The required volume of milk to feed a calf was estimated to be 500 lit.

(3) Average milk production per lactation per head

On an average, the milk production per lactation by Jersey breed is 3,000 lit. in Japan and Europe. On the other hand, according to the results obtained by CNRZ at Sotuba, milk production per lactation by a Jersey x local species half-bred cows 1,200 - 2,500 lit. (See Table V.18). Taking into consideration the rather severe climatic conditions in the hot project area, it would not be possible to expect a milk production of 3,000 lit. per lactation even with the introduction of pure-bred species in the area. An average production of 2,500 lit. of milk per lactation would seem reasonable, and this quantity is therefore applied in the present livestock development plan.

(4) Cattle number

The required cattle number was determined to be 1,460 head based on various milk production standards mentioned below:

(a)	Production per lactation	:	2,500 lit.
(b)	Period between calvings	:	15 months
(c)	Mean annual production during a location (2,500 lit. x 12 months/15 months)	:	2,000 lit.
(d)	Number of calves to be fed by a milk-cow	:	0.165 head
(e)	Volume of milk required for feeding a calf	:	500 lit.
(f)	Volume of milk to be fed by a milk-cow (0.165 head x 500 lit.)	:	80 lit.
(g)	Mean annual production of marketable milk (2,000 lit. - 80 lit.)	:	1,920 lit.
(h)	Annual production anticipated by ULB (9,000 lit./day x 312 days /1)	:	2,808 k lit.
(i)	Required number of milk cattle (2,808 k lit/1,920 lit.)	:	1,460 head

Remarks: /1: Number of working days of ULB plant

After the 6th calving, the cows would be discharged and sold to slaughter. In order to make up for the discharged cows, it would be necessary to raise another 680 calves and heifers. Therefore, the total number of cattle to be raised in the project area would be 2,140 head.

Herd Composition	Number of Head
(a) Milk-cow	1,460
(b) Calves (0 - 11 months old)	240
(c) Calves (12 - 23 months old)	220
(d) Cows in 1st calving (24 - 35 months)	220
Total	2,140

(5) Milk and meat productions

The milk and meat productions envisaged in the livestock production plan are as shown in Table V.19. The total production of raw milk is estimated to be 2,920 k lit. per year, out of which 120 k lit. would be directly consumed by calves and the remaining 2,800 k lit. would be supplied to ULB. As to meat production, the discarded and discharged cows would be used for this purpose. Their total number would be 220 head per year.

V.4.3 Fodder Cropping

(1) Selection of varieties

Both fodder grasses and pulses rich in nitrogen would be introduced in the project area. Based on the results of variety trials by CNRZ at Sotuba, the following high-yielding varieties were selected.

Fodder grasses	(Vernacular names)
- Panicum maxima	(Herbe de Guinée)
- Echinochla stagnima	(Bourgou, Gamaraival)
- Pennisetum purpurem	(Napier, Herbe à éléphant)
Fodder pulses	
- Stylosanthes guianensis	(Luzerne tropicale, Luzerne de Brésil)

(2) Cropping pattern and farming practices

The fodder cropping pattern is shown in Fig. V.3. On the basis of growth cycle and fodder value at each growth stage, it was planned that 6 cuts would be carried out annually. In general the fodder values such as MAD (digestible nitrogenous matter) and UF (fodder units) have tendency to decrease considerably from 2 months after planting or regrowth (See Table V.22). It would be necessary therefore to cut the fodder plants every two months.

Fodder production decreases gradually due to overgrowth of weeds and bushes and denudation of land. Usually fodder re-planting is made every 3 to 5 years in this area, but in order to ensure sufficient production it is proposed that fodder cultivation will be started anew every 3 years in the project area. The recommended farming practices are as shown in Table V.21, and mechanized farming method would be introduced for the following reasons:

(a) To ensure efficient feeding of the milk herd with green fodder.

(b) Manual farming will require considerably large man-power even for such operations as ploughing and spraying. On the other hand, as the works will have to be carried out rapidly, the use of machinery would be preferable for rational execution of the works at the least cost.

The method of direct sowing at a rate of 14 kg of seeds per hectare would be applied for cultivation of Panicum maximum and Stylosanthes guyanensis fodder varieties. As for Echinochla Stagina and Pennisetum purpureum varieties, planting by use of cuttings or stump fragments would be practiced. Annual fertilizer application was estimated to be 280 kg of N, 230 kg of P_2O_5 and 170 kg of K_2O per hectare, based on standard practice in Japan. Actual requirement of fertilizer should be determined later according to the results of trial cultivations at the Livestock Section of the Production Division of the Baguineda Operation.

(3) Green fodder and dry matter yields

The fodder crop yields were estimated on the basis of the harvests by CNRZ at Sotuba and by referring to the "Mémento de l'Agronome", as follows:

Varieties	CNRZ Sotuba	Memento de l'Agronome		
	Green Fodder Yield (t/ha)	Hay Yield (t/ha)	Dry Matter (%)	Green Fodder Yield (t/ha)
- Panicum maximum	100	25	17.9	140
- Echinochla stagira	100	30	20.7	145
- Pennisetum purpureum	130	-	-	-
- Stylosanthes guyanensis	40	10	22.0	45

The results obtained by CNRZ were poor because of inadequate watering with tap water. The low yield was also attributable to minimum application of fertilizer (N: 70 kg, P_2O_5: 46 kg, K_2O: 60 kg) and irrational cutting schedule.

The results shown in the "Mémento de l'Agronome" are rather high. Fodder farming with such results would have been carried out very intensively in the countries where climatic conditions are favorable enough. After careful study of the above results, the green fodder yields obtained by CNRZ were retained in the evaluation of the yields of fodder crops to be introduced in the project area. These yields could be ensured by introduction of a very intensive fodder farming method through perennial irrigation and appropriate fertilizer application as mentioned above.

As to the yields in dry matters, MAD (digestible nitrogenous matter) and UF (fodder units) values were estimated to be 1,320 kg and 9,940 kg respectively, by calculating the average yields of 4 fodder varieties based on the "Mémento de l'Agronome".

Details of the green fodder and dry matter yields are given in Table V.20, V.22 and V.23.

(4) Area and production of fodder crops

Energy requirement for raising a milk herd of 2,140 head was calculated on the basis of standard weight by age and standard energy requirement of Jersey breed. Standard weights by age of Jersey breed are as shown below (Refer to Fig. V.4, Standard Growth Curve of Milk Cows):

Age	Average Weight	Weight Increase per Day (kg/day)
Cows in lactation (over 37 months)	350	-
Calves (1 - 6 months)	65	0.50
Calves (7 - 12 months)	150	0.43
Heifers (13 - 18 months)	220	0.33
Heifers (19 - 24 months)	275	0.27
Cows in 1st calving (25 - 36 months)	320	0.11

The standard growth curves exhibited in Fig. V.4 were drawn based on the data available in Japan for Jersey Species and in Mali for N'dama Species. The standard weight of over 3 - 4 years old heifers in Europe and Japan is usually 400 kg, but in this report it was estimated to be 350 kg only taking into consideration the tropical climate, particularly the high temperature. This weight would be equivalent to the maximum weight of a Jersey x N'dama half-breed of over 3 - 4 years in age (See Table V.18).

Table V.24 shows standard energy requirement for milk herd raising. According to this table, the annual energy requirement for 2,140 head would be 381,000 kg of MAD or 3,545,000 UF (See Table V.25).

The total planting area of fodder crops was determined on the basis of annual energy requirement and production per hectare of MAD and UF as shown in the following table (See also Table V.25):

	MAD	UF
a) Annual energy requirement for dairy farming	381,000 kg	3,545,000
b) Production per hectare of energy values	1,320 kg	9,940
c) Net planting area of fodder crops (a)/b))	289 ha	357 ha
d) Allowance (for variations in requirements)	10 %	10 %
e) Require area for improved fodder cropping	318 ha	393 ha (≒ 400 ha)

The total planting area of fodder crops required for raising a herd of 2,140 head was estimated to be 400 ha and the annual production of fodder 37,200 t.

(5) Location of pasture lands

The dairy farming facilities mentioned in Section V.4.4 should be as far as possible located in or near the pasture lands in order to facilitate various farm operations. On the other hand, the cowsheds should be installed in easily accessible places so as to ensure immediate milk transport to the ULB plant. For these reasons, three areas are proposed for fodder cropping: 140 ha on the left bank of Fara river, 130 ha on the right bank of the same river and 130 ha to the west of Baguineda camp.

The dairy farm (consisting of 3 dairy stations) would be located at about 41 km from the ULB plant at Sotuba and partly connected by the large Bamako - Segou road. This road is 6 m wide, and the section of about 37 km between Bamako and Kobalakoro village is asphalted but the remaining section of about 4 km connecting this village and the envisaged pasture land is not asphalted.

The above areas are selected for fodder cropping because, in view of their topography, levelling work will be required if rice would be cultivated therein. Another reason for the choice is the proximity of these areas to the Directorate of Baguineda Operation, which is very convenient for livestock development.

V.4.4 Facilities and Equipment Required for Dairy Farm

(1) Farm machinery

The mechanized farm operations for fodder cropping on 400 ha are as detailed in Table V.21. The necessary number of machine and equipment estimated based on their respective capacity as mentioned in Table V.26, is shown below:

Description		Quantity
1) Tractors		
- Wheeled type (60 ps)		2 nos.
- Wheeled type (45 ps)		11 nos.
2) Attachments		
- Manure spreader	(2.2 m^3)	1 no.
- Disk plough	(26" x 3 rows)	1 no.
- Disk harrow	(18" x 24 rows)	1 no.
- Fertilizer broadcaster	(16 rows)	1 no.
- Roller	(2.4 m)	1 no.
- Mower	(1.5 m)	3 nos.
- Trailer	(3 t)	6 nos.
- Lower	(400 lit.)	2 nos.

The features of farm machinery are described in Table V.27. Their required number and capacity are determined on the following basis:

(a) Number of working days per year (except for holidays): 255 days
(b) Working hours per day for general work : 6 hours
(c) Working hours per day for mowing and gathering : 10 hours (2 shifts)

Repairs and maintenance of the above-mentioned machinery will be made in the existing workshop of the Baguineda Operation.

(2) Facilities required for dairy farm

The facilities required for raising a herd of 2,140 head are mentioned below. These facilities would be installed in three respective pasture areas as shown in the map of General Plan.

Facilities	Number Required for 1 Station	Total Number
Cowshed (520 m^2)	6	18
Drinking trough	1	3
Milk refrigerator (2,800 lit.)	1	3
Antiparasitic cattle dip	1	3
Exercise area	19,200 m^2	57,600 m^2
Pasture fence	1,000 m	3,000 m
Office (80 m^2)	1	3

General plan of a cowshed is as illustrated in Fig. V.5. The cowsheds would have no walls for reasons of limited budget and sanitary conditions such as temperature and aeration.

Taking into consideration the requirements of an intensive dairy farming such as feeding, milking, health cares, artificial insemination, etc., each shed is designed to accommodate 82 cows. Some partitioned maternity rooms would be provided in each shed for the purposes of calving and nursing of calves.

As the milking will be made by hand, it would be indispensable to preserve the milk from heat and any eventual pollution. Therefore, adequate refrigeration equipment would have to be installed in each dairy station.

One antiparasitic cattle dip would be provided in each station (See Fig. V.6). Related facilities such as drinking trough, exercise area, fence, office, etc. would also be installed as shown in the general layout in Fig. V.7. The 3 dairy stations, each with an area of 29,000 m2, would be located in or near the proposed fodder planting areas. Total area of the 3 stations would be 8.7 ha.

V.4.5 Man Power Requirements

Personnel and labour requirements for dairy farm operations are mentioned below:

Position	Quantity
1) Permanent staff	
- Manager	1
- Office employee	2
- Typist	1
- Milker	144
- Operator of machinery	22
- Inseminator	3
- Assistant inseminator	3
2) Temporary or seasonal labourer	
- for dairy farm operation (75 days x 144 persons)	10,800 man-days
- for fodder cropping (67 ha x 80 persons/day/ha)	5,360 man-days

Eight milkers would take care of 10 cows in lactation. The required number of milkers for 3 stations would be 144 in total. Temporary or seasonal labourers would replace the milkers on holidays or would carry out the replanting of fodder crops every 3 years.

In order to ensure the training of technical staff, it would be recommendable that the dairy farm be operated under direct control of the Baguineda Operation. Advanced dairy farming practice would require the employment of technicians specialized in farm mechanization, milking, artificial insemination, etc.

The livestock section of the Baguineda Operation is raising as present a herd of 80 head as of April 1985. Besides, its rural engineering division which has repair shops and a staff consisting of 7 mechanic and 13 machine operators, can undertake the repairs and maintenance of machinery and equipment. Accordingly, it would be advisable to develop and strengthen

the future organization of the dairy farm from the existing nucleus of the Baguineda Operation.

With regard to artificial insemination, as the Baguineda Operation has no equipment for this operation, it would be entrusted to the inseminators of CNRZ at the initial stage of the dairy farming. However, the Baguineda Operation would undertake artificial insemination after completion of training and formation of its own technicians.

V.5 Marketing and Price Forecast

V.5.1 Forecast of demand and supply of agro-pastoral products

(1) Cereals

Average annual production of rice between 1978 and 1982 was 107,000 t and that of other cereal crops was 980,000 t as presented in Table V.28. The Government of Mali had to import, at its own cost or on grant basis, 91,000 t/y of cereals during the said period. Estimated annual consumption of cereals from 1978 to 1982 amounts to 1,178,000 t.

Consumption per capita of cereals was calculated by dividing the total volume of locally produced and imported cereals by the total population, as shown in Table V.29. The annual ration per inhabilitant in Mali ranges from 160 kg to 220 kg, or about 177 kg on an average consisting of 20.8 kg of rice and 156.2 kg of other cereals.

Forecast of cereals demand in Mali and in Bamako capital city was made on the basis of the consumption per capita mentioned above, and on the following assumptions:

(a) Annual consumption increase rates were estimated to be 2% for rice and 0.2% for other cereals.

(b) Annual growth rate of population would be 2.5% per year.

The volumes of cereals required in the years 1990 and 2000 were estimated as shown below:

(Unit: 10^3 t)

Year	Rice (Paddy)	Other Cereals	Total
1990	221 (339)	1,437	1,658
1995	276 (424)	1,642	1,918
2000	344 (530)	1,877	2,221

Details of the above estimation are given in Table V.30. By lack of the recent data showing the projection of the future cereals production in Mali, it is assumed that the future production will not increase from the present production level, i.e. 107,000 t/year of rice and 980,000 t/year of other cereals.

Based on this assumption, shortage of cereals in Mali is as shown below:

(Unit: 10^3 t)

Year	Rice (Paddy)	Other Cereals	Total
1990	114 (175)	457	571
1995	169 (260)	662	831
2000	237 (365)	897	1,134

As well as the total demand at national level, the regional demand in Bamako would also increase substantially and attain to 163,000 t in 1995 which is broken down to 23,000 t of rice and 140,000 t of other cereals. (See Table V.30)

Apart from the demand projection, the net incremental production of cereals owing to the project realization was estimated to be 9,210 t of paddy (or about 5,990 t of rice) and 4,800 t of other cereals as shown below:

(Unit: t)

Crop	With Project	Without Project	Increment
Paddy	9,600	390	9,210
Maize	4,800	240	4,560
Sorghum & Millet	400	160	240

The remaining marketable cereal products after deducting self-consumption in the project area would amount to 5,600 t of rice and 1,900 t of other cereals in 1995. (See Table V.31) In view of the favourable location of the project area, it is apparent that the surplus cereals would easily find markets in Bamako and partly meet the regional demand of cereals.

(2) French beans

French beans are cultivated mainly by farmers organized by the Baguineda Operation and partly by farmers in surrounding areas. It is mostly sold to and exported by FRUITEMA. According to the forecast of exports by FRUITEMA, the quantities of French beans to be exported in 1985/86 would be 200 - 400 t. (See Table III.8) Demands for that in local market as well as in Europe show a tendency of increase. Therefore, it would be necessary to plan for the augmentation in their production to meet such demands.

(3) Tomato

As said in Section III.4, there exists a tomato cannery (SOCAM) in the project area, with a gross processing capacity of 8,100 t of raw tomatoes (over a period of 6 months). However, due to lack of raw material, the operation of the SOCAM plant is being hindered.

At the final stage of project operation from 1995, a quantity of 8,750 t of tomatoes would be produced annually. Out of this, 8,100 t would be supplied to the SOCAM plant and the remainder would be self-consumed or sold to markets in Bamako.

(4) Milk and beef

At its final operation stage, the dairy farm would produce 2,800 k lit. of milk and 220 head of beef cattle per annum. The milk would be supplied to the ULB plant. Considering the shortage of raw milk for processing by the plant, the milk supply from the Project would certainly contribute to the stable operation of ULB.

The discarded or discharged cows from the dairy farm would be slaughtered in AFB and their meat would be sold to local markets and Bamako markets. The carcass production capacity of AFB is about 10,000 t per year and its beef production for 5 years from 1975 to 1979 averaged 8,000 t a year.

Carcass production by the dairy farm was estimated to be about 46 t/year, calculated as follows:

220 head x 350 kg (live weight) x 0.6 (meat yield) = 46,000 kg

The above-mentioned production is quite insignificant as compared to the marginal capacity of AFB (2,000 t) and the carcass consumption of 8,000 t/year in Bamako and its surrounding areas. Therefore, it would be easy to find a market for the meat produced under the Project.

V.5.2 Price forecast for agro-pastoral produce and inputs

Economic and financial prices of agro-pastoral produce and inputs were evaluated on the following basis:

(1) Economic prices

(a) Calculation of actual prices of export-substitute or import products was based on international market prices of exported or imported products;

(b) Actual prices of some products were estimated by referring to the prices forecast by the World Bank for 1995 (from current 1985 prices) for products available in international market;

(c) Customs duty and import tax, etc., estimated to be 13% in domestic market in Mali, were deducted from actual prices;

(d) Actual prices of local products are factory-gate prices or local market prices of said products.

(2) Financial prices

These are the factory-gate prices or local market prices estimated in Section III.4.

Economic and financial prices by agro-pastoral produce and inputs are shown respectively in Tables V.32, V.33 and Tables III.7. Estimation of the above prices for the respective products was also made under the following basic conditions:

(a) Cereal products

Government of Mali is now importing 91,000 t of cereals on an average per year. Taking into account the population growth rate of 2.5% per year, annual food demand of the people of Mali and cereals production trend, it seems possible that the food shortage will continue for some years in the future. The anticipated production of 5,990 t of rice and 4,800 t of other cereals (maize, sorghum and millet) in the project area would be intended for self-consumption, supply to markets in Bamako and, in particular, for substitution for imported cereals.

Estimated on the basis determined above, the economic farm-gate prices would be 204 F CFA/kg for rice, 124 F CFA/kg for maize and FM123/kg for both sorghum and millet. (See Table V.34) As for estimation of financial prices of cereal products, the farm-gate prices prevailing in the project area were applied.

(b) French beans

French beans are exported out of season by FRUITEMA to Europe and the Middle East. Therefore, the purchase prices of these products by FRUITEMA from farmers are taken as both economic and financial prices in the calculation.

(c) Tomato and other vegetables

As tomatoes and other vegetables produced under the Project would be totally consumed in the country, the farm-gate prices of these products are taken as both economic and financial prices in the calculation.

(d) Milk and beef

Milk products will be processed by the ULB plant at Sotuba. Therefore, the factory buying price is taken as both economic and financial prices in the calculation.

As to the meat, its price evaluation is rather difficult for lack of basic data. The producer prices are considered as both economic and financial prices in the evaluation.

(e) Farm implement and inputs

Most of the implement and inputs required for the envisaged agro-pastorol production, such as farm machinery, fertilizer, insecticides, etc. are to be imported from abroad. Their economic prices are estimated based on the import prices in Bamako and their adopted financial prices are those in local market in the project area.

V.6 Farmers Resettlement Plan

V.6.1 General

The active work force estimated to be 3,600 persons at present in Baguineda Area would not be sufficient to meet the labour requirement for the proposed development plan. This fact would constitute one of the serious constraints to agricultural production in the project area. In order to realize the introduction of intensive farming practice in the area, it would be essential to transmigrate farm households into the project area.

V.6.2 Land distribution and population to be settled

(1) Land distribution

The available labour force per farm household is estimated to be 4.2 persons based or the data provided by the Baguineda Operation as shown below:

Sub-area	No. of Household	Population		Per Household	
		Total	Active /1	Total	Active /1
Koba	172	1,436	781	8.3	4.5
Upper Baguineda	523	3,266	1,777	6.2	3.4
Lower Baguineda	112	1,583	726	14.1	6.5
Tanima	52	614	285	11.8	5.5
Sierkoro	18	165	75	9.2	4.2
Total Ave.	877	7,064	3,641	8.1	4.2

Remark: /1: 14 - 60 years old

According to the estimation of farm labour requirement, the peak man-power demand is caused in June at 2.4 persons/day/ha. This means that the average household can cultivate 1.2 ha of farm land by 3 persons which was proposed in the previous feasibility study. Besides, the farmers generally have 2.1 ha of farm land outside the project area. It is assumed that farmers would continue to sustain such land even under the future with-project condition. Therefore some labour (1.2 persons) could be devoted to cultivate a part of their lands outside the project area and to provide man-power for milk production of the Baguineda Operation.

(2) Population to be resettled

After deduction of a part of irrigated land for stable-controlled fodder farming, the net area available for agricultural development by smallholder system would be 2,600 ha. The total number of households to be resettled in these 2,600 ha was estimated to be 2,166. Out of this figure, 877 families are living in or around the project area and another 1,289 families would come from other regions. The number of farmers to be resettled is estimated as below:

Sub-area	Irrigation Area (ha)	Area to be Allocated to the Farmers (ha)	Households (nos.)		
			Required	Existing	Resettled
Koba	557	557	464	172	292
Upper Baguineda	555/1	295	246	523	-277
Lower Baguineda	1,424/1	1,284	1,070	112	958
Tanima	160	160	133	52	81
Sienkoro	304	304	253	18	235
Total	3,000	2,600	2,166	877	1,289

Remarks: /1: *including 400 ha of pasture in total*

As shown above, 1,289 households are required to be resettled from outside the project area. In Upper Baguineda, the number of existing households exceeds the requirement. Totally 277 households will be resettled to the other areas, i.e. Koba or Lower Baguineda.

New villages of resettled farm households would be established in the area in such a manner that families of same ethnic origin will be grouped together. With a view to facilitating the transportation of farm inputs and products, communication between the villages and communication of farmers between their home and cultivating lands, it would be recommendable to locate the villages in the southern part of the project area, on the highland extending along the main canal from Sotuba water intake to Tanima Village.

V.6.3 Selection of farmers for resettlement

The result of the resettlement plan would greatly depend upon the fitness and capability of farming of the families to be resettled in the area. Selection of farmers for resettlement would be carried out on the basis of the following qualifications.

Each member of the families to be resettled shall be: a) a citizen of Mali, b) in good health, c) capable of executing farm work. Each family shall have an active labour force of at least 3 persons.

It is to be noted that the size of a farm household would be an important factor to be considered in order to satisfy adequately the labour requirement for an intensive irrigated farming.

V.6.4 Government support and resettlement procedure

(1) Government support

Farm households to be resettled in the project area would need an initial capital investment for construction of their houses and for purchase of a pair of oxen and farm equipment. These farmers have no own financial means to cover necessary expenses for resettlement and cultivation. Therefore, the Government would have to assist them by providing them with agricultural beans or credits.

Under the current Mopti Rice project, the medium-term (4 year) credit would be provided through the National Agricultural Development Bank (BNDA) for the purchase of a pair of work oxen and soil tillage equipment by individual unequipped farmers. Referring to the experiences in the Mopti project, the purchase of equipment through a credit is proposed under the project. For the newly resettled farmers, housebuilding cost and a pair of oxen are added to the equipment.

The total amount of agricultural credit to be extended by the Government is estimated to be 1,372 million F CFA described below:

Item	New Installation (10^3 F CFA/family)	Re-installation (10^3 F CFA/family)	Total (10^6 F CFA)
Housing	115	-	148
A pair of oxen	200	-	258
Farm equipment	446	446	966
Total	761	446	1,372

A breakdown of the above amount is given in Table VI.1.

The agricultural beans or credits would be granted by BNDA to the farmers through the Baguineda Operation. Considering the low repayment capacity of farmers at the initial stage of farming, very soft conditions would have to be applied for the agricultural beans or credits. Based on the result of a comparative study on various loan conditions and repayment capacity of farmers, the following soft conditions would be recommended:

- Interest rate : 2% per annum
- Grace period : 3 years
- Repayment period (not including 3-year grace period) : 7 years

(2) Resettlement procedure

The resettled farm families will have to earn their living during the initial period of agricultural development after their arrival in the project area. To this end, it is necessary that the farmers could be resettled in the area six months before commencement of the project construction works and that they should participate in these works.

V.6.5 Resettlement schedule

The resettlement schedule would mainly follow the project construction schedule. As the farmers should engage themselves in the construction works, it was planned that their resettlement be made progressively by sectors because the construction works would be carried out also in the same manner.

A total of 1,289 farm households would be newly transmigrated into the project area during a period of 2 years from the 2nd year after commencement of construction works. The resettlement schedule is summarized below:

Year	To be Newly Transmigrated	To be Resettled within the Area	Commencement of Cropping
1987	-	464	1988 rainy season
1988	15	231	1989 rainy season
1989	958	112	1990 dry season
	316	70	1990 rainy season
Total	1,289	877	

Table V.1 PROPOSED FARMING PRACTICES FOR PADDY

	A	M	J	J	A	S	O	N	Labour Requirement (man-day)	Machinery and Equipment	Farm Inputs per Hectare
I) Cropping Pattern											
II) Farming Practices											
1) Nursery preparation/1									5	Plough Tooth harrow	Nursery bed: 400m^2 Seed: 30 kg
2) Ploughing									11	Multi-cultivator	N:1kg, P_2O_5:1kg, K_2O:1kg
3) Basal application of fertilizer									4	(manpower)	N:129kg, P_2O_5:29kg, K_2O:29kg
4) Harrowing									2	Tooth harrow	
5) Puddling (twice)									6	Puddling rake	
6) Levelling/2									3	Levelling board	
7) Transplanting									35	(manpower)	
8) Top dressing -1st									2	(manpower	N: 30kg
Top dressing -2nd									4	(manpower)	N:30kg, P_2O_5:30kg, K_2O:30kg
Top dressing -3rd									2	(manpower)	N:30kg
9) Application of insecticide -1st									4	Knapsack-type sprayer	Insecticide: 1 lit.
Application of insecticide -2nd									4	Knapsack-type sprayer	Insecticide: 1 lit.
Application of insecticide -3rd									4	Knapsack-type sprayer	Insecticide: 1 lit.
10) Application of fungicide									4	Knapsack-type sprayer	Fungicide : 1 lit.
11) Weeding -1st									5	(manpower)	
Weeding -2nd									5	(manpower)	
Weeding -3rd									5	(manpower)	
12) Irrigation									10	(manpower)	
13) Harvesting and hauling									30	(manpower)	
14) Drying and threshing									10	Pedal thresher, winnower	
15) Packing and transportation									10	Oxcart	Jute bag: 80 nos.
Man-day required									165		

Remarks: /1: This comprises ploughing, harrowing, seeding and irrigation, etc.
/2: Spacing at 30cm x 10cm

Table V.2 PROPOSED FARMING PRACTICES FOR MAIZE

	N	D	J	F	M	A	M	J	Labour Requirement (man-day)	Machinery and Equipment	Farm Input per Hectare
I) Cropping Pattern											
II) Farming Practice											
1) Ploughing									11	Plough	
2) Basal application of fertilizer									4	(manpower)	N:35kg, P_2O_5:92kg, K_2O:60kg
3) Harrowing (twice)									4	Tooth harrow	
4) Ridging									3	Ridger	Furrow: 80cm
5) Seeding/1									3	Drill seeder	Seed: 25kg Row: 25cm
6) Spacing									2	(manpower)	
7) Top dressing -1st									2	(manpower)	N: 35kg
Top dressing -2nd									2	(manpower)	N: 35kg
8) Application of insecticide									4	Knapsack-type sprayer	Insecticide: 1 lit.
9) Application of fungicide									4	Knapsack-type sprayer	Fungicide: 1 lit.
10) Weeding -1st									5	(manpower)	
Weeding -2nd									5	(manpower)	
11) Irrigation									10	(manpower)	
12) Harvesting and hauling									30	(manpower)	
13) Drying and threshing									10	Corn sheller	
14) Packing and transportation									6	Oxcart	Jute bag: 60 nos.
Man-day required									105		

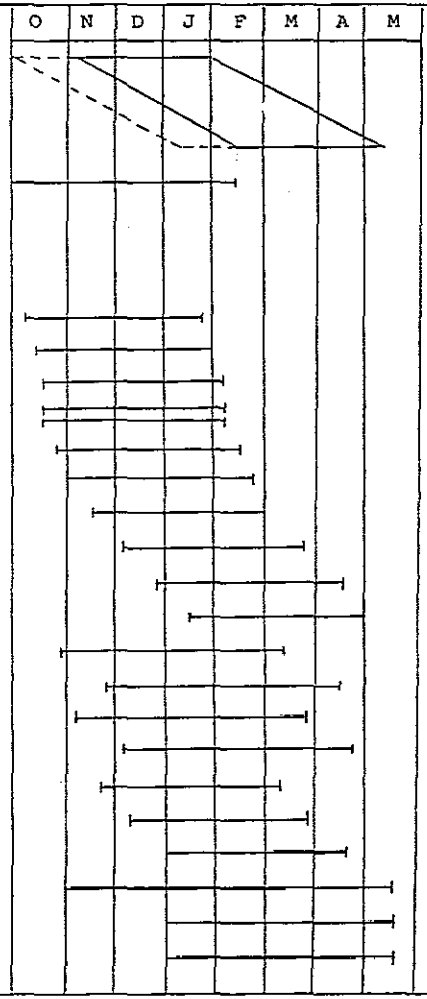
Remarks: /1: Plant density: 50,000 plants/ha

Table V.3 PROPOSED FARMING PRACTICES FOR SORGHUM AND MILLET

	O	N	D	J	F	N	A	M	Labour Requirement (man-day)	Machinery and Equipment	Farm Input per Hectare
I) Cropping Pattern											
II) Farming Practice											
1) Plough									11	Plough	
2) Basal application of fertilizer									4	(manpower)	N:22kg, P_2O_5:46kg, K_2O:36kg
3) Harrowing (twice)									4	Tooth harrow	
4) Ridging									3	Ridger	Furrow: 80cm
5) Seeding/1									3	Drill seeder	Semence: 8kg Row: 25cm
6) Spacing									2	(manpower)	
7) Top dressing -1st									2	(manpower)	N: 21kg
Top dressing -2nd									2	(manpower)	N: 21kg
8) Application of insecticide									4	Knapsack-type sprayer	Insecticide: 1 lit.
9) Application of fungicide									4	Knapsack-type sprayer	Fungicide: 1 lit.
10) Weeding -1st									5	(manpower)	
Weeding -2nd									5	(manpower)	
11) Irrigation									10	(manpower)	
12) Harvesting and hauling									30	(manpower)	
13) Drying and threshing									10	(manpower)	
14) Packing and transportation									6	Oxcart	Jute bag: 40 nos.
Man-day required									105		

Remarks: /1: Plant density: 50,000 plants/ha

Table V.4 PROPOSED FARMING PRACTICES FOR TOMATO



	Labour Requirement (man-day)	Machinery and Equipment	Farm Input per Hectare
I) Cropping Pattern			
II) Farming Practice			
1) Nursery preparation/1	120	Plough Tooth harrow Knapsack-type sprayer	Nursery bed: 200m^2 Seed: 0.4kg N:4kg, P_2O_5:2kg, K_2O:4kg Insecticide, fungicide, Rice straw/2, etc.
2) Application of compost & manure	10	Oxcart	Compost: 10t
3) Ploughing	11	Plough	
4) Basal application of fertilizer	4	(manpower)	N:37kg, P_2O_5:59kg, K_2O:103kg
5) Harrowing (twice)	4	Tooth harrow	
6) Ridging	2	Ridger	Furrow 120cm x Row 45cm
7) Transplanting/3	80	(manpower)	
8) Application of fertilizer -1st	2	(manpower)	N: 36kg
Application of fertilizer -2nd	2	(manpower)	N:36kg, P_2O_5:59kg, K_2O:103kg
Application of fertilizer -3rd	2	(manpower)	N: 36kg
Application of fertilizer -4th	2	(manpower)	N: 36kg
9) Application of insecticide -1st	4	Knapsack-type sprayer	Insecticide: 1 lit.
Application of insecticide -2nd	4	Knapsack-type sprayer	Insecticide: 1 lit.
10) Application of fungicide -1st	4	Knapsack-type sprayer	Fungicide: 1 lit.
Application of fungicide -2nd	4	Knapsack-type sprayer	Fungicide: 1 lit.
11) Weeding -1st	5	(manpower)	
12) Weeding -2nd	5	(manpower)	
13) Weeding -3rd	5	(manpower)	
12) Irrigation	10	(manpower)	
13) Harvesting and hauling	180	(manpower)	
14) Packing and transportation, etc.	40	Oxcart	
Man-day required	500		

Remarks: /1: This comprises seeding, mulching, seed treatment, irrigation, fertilization, etc.
/2: Mulching
/3: Plant density: 18,000 plants/ha

Table V.5 PROPOSED FARMING PRACTICES FOR FRENCH BEANS

	S	O	N	D	J	F	M	A	Labour Requirement (man-day)	Machinery and Equipment	Farm Input per Hectare
I) Cropping Pattern											
II) Farming Practice											
1) Ploughing									11	Plough	
2) Basal application of fertilizer									4	(manpower)	N:60kg, P_2O_5:110kg, K_2O:150kg
3) Harrowing (twice)									4	Tooth harrow	
4) Ridging									5	Ridger	Furrow: 60cm
5) Seeding/1									4	Drill seeder	Seed: 100kg Row: 30cm
6) Spacing									2	(manpower)	
7) Top dressing									2	(manpower)	N: 50kg
8) Application of insecticide									4	Knapsack-type sprayer	Insecticide: 1 lit.
9) Application of fungicide									4	Knapsack-type sprayer	Fungicide: 1 lit.
10) Weeding -1st									5	(manpower)	
Weeding -2nd									5	(manpower)	
11) Irrigation									10	(manpower)	
12) Harvesting and hauling									70	(manpower)	
13) Packing and transportation									10	Oxcart	Carton box: 100 nos.
Man-day required									140		

Remarks: /1: Plant density: 55,000 plants/ha

Table V.6 PROPOSED FARMING PRACTICES FOR ONION

Farming Practice	Labour Requirement (man-day)	Machinery and Equipment	Farm Inputs per Hectare
1) Nursery preparation/1	120	- Plough - Tooth harrow	- Nursery bed: 200m^2 - Seed: 5kg - N: 3kg, P_2O_5: 3kg, K_2O: 3kg - Insecticide, fungicide, rice straw, etc.
2) Application of compost	10	- Oxcaft	- Compost: 10t
3) Ploughing	11	- Plough	
4) Basal Application of fertilizer	4	(manpower)	- N: 25kg, P_2O_5: 36kg, K_2O: 66kg
5) Harrowing	4	- Tooth harrow	- twice
6) Ridging	2	- Ridger	- Furrow: 30cm
7) Transplanting	80	(manpower)	- Row: 10cm - Plant density: 330,000 plants/ha
8) Top dressing -1st	*/2	(manpower)	- N: 2kg
Top dressing -2nd	2	(manpower)	- N: 25kg
Top dressing -3rd	4	(manpower)	- N: 25kg, P_2O_5: 36kg, K_2O: 66kg
Top dressing -4th	2	(manpower)	- N: 25kg
9) Application of insecticide -1st	4	- Knapsack-type sprayer	- Insecticide: 1 lit.
Application of insecticide -2nd	4	- Knapsack-type sprayer	- Insecticide: 1 lit.
10) Application of fungicide -1st	4	- Knapsack-type sprayer	- Fungicide: 1 lit.
Application of fungicide -2nd	4	- Knapsack-type sprayer	- Fungicide: 1 lit.
11) Weeding -1st	5	(manpower)	
Weeding -2nd	5	(manpower)	
Weeding -3rd	5	(manpower)	
12) Irrigation	10	(manpower)	
13) Harvesting and hauling	110	(manpower)	
14) Packing and transporting	30	- Oxcart	- Jute bag: 400 nos.
Man-day required	420		

Remarks: /1: This comprises seeding, mulching, seed treatment, irrigation, etc.
/2: Negligeble

Table V.7 PROPOSED FARMING PRACTICES FOR POTATO

Farming Practice	Labour Requirement (man-day)	Machinery and Equipment	Farm Inputs per Hectare
1) Application of compost	10	- Oxcart	- Compost: 10t
2) Ploughing	11	- Plough	
3) Basal application of fertilizer	4	(manpower)	- N: 34kg, P_2O_5: 100kg, K_2O: 50kg
4) Harrowing	4	- Tooth harrow	- Twice
5) Ridging	5	- Ridger	- Furrow: 60cm
6) Planting	80	(manpower)	- Seed tuber: 1.2t - Row: 30cm - Plant density: 55,000 plants/ha
7) Top dressing -1st	2	(manpower)	- N: 33kg, K_2O: 50kg
Top dressing -2nd	2	(manpower)	- N: 33kg, K_2O: 50kg
8) Application of insecticide -1st	4	- Knapsack-type sprayer	- Insecticide: 1 lit.
Application of insecticide -2nd	4	- Knapsack-type sprayer	- Insecticide: 1 lit.
9) Application of fungicide -1st	4	- Knapsack-type sprayer	- Fungicide: 1 lit.
Application of fungicide -2nd	4	- Knapsack-type sprayer	- Fungicide: 1 lit.
10) Weeding	5	(manpower)	
11) Field maintenance -1st	15	(manpower)	
Field maintenance -2nd	15	(manpower)	
12) Irrigation	10	(manpower)	
13) Harvesting and hauling	160	(manpower)	
14) Packing and transporting	21	- Oxcart	- Jute bag: 160 nos.
Man-day required	360		

Table V.8 PROPOSED FARMING PRACTICES FOR WATERMELON

Farming Practice	Labour Requirement (man-day)	Machinery and Equipment	Farm Inputs per Hectare
1) Application of compost	10	- Oxcart	- Compost: 10t
2) Ploughing	11	- Plough	
3) Basal application of fertilizer	4	(manpower)	- N: 55kg, P_2O_5: 75kg, K_2O: 95kg
4) Harrowing	4	- Tooth harrow	- Twice
5) Ridging	1	- Ridger	- Furrow: 240cm
6) Seeding	5	(manpower)	- Seed: 2kg - Row: 180cm
7) Spacing	2	(manpower)	- Plant density: 2,300 plants/ha
8) Top dressing -1st	2	(manpower)	- N: 55kg
Top dressing -2nd	2	(manpower)	- N: 55kg, P_2O_5: 75kg, K_2O: 95kg
Top dressing -3rd	2	(manpower)	- N: 55kg
9) Application of insecticide -1st	4	- Knapsack-type sprayer	- Insecticide: 1 lit.
Application of insecticide -2nd	4	- Knapsack-type sprayer	- Insecticide: 1 lit.
10) Application of fungicide -1st	4	- Knapsack-type sprayer	- Fungicide: 1 lit.
Application of fungicide -2nd	4	- Knapsack-type sprayer	- Fungicide: 1 lit.
11) Weeding -1st	5	(manpower)	
Weeding -2nd	5	(manpower)	
Weeding -3rd	5	(manpower)	
12) Irrigation	10	(manpower)	
13) Harvesting	70	(manpower)	
14) Transporting, etc.	16	- Oxcart	
Man-day required	170		

Table V.9 PROPOSED FARMING PRACTICES FOR OKRA

Farming Practice	Labour Requirement (man-day)	Machinery and Equipment	Farm Input per Hectare
1) Application of compost	10	- Oxcart	- Compost: 10t
2) Ploughing	11	- Plough	
3) Basal application of fertilizer	4	(manpower)	- N: 39kg, P_2O_5: 60kg, K_2O: 24kg
4) Harrowing	4	- Tooth harrow	- Twice
5) Ridging	2	- Ridger	- Furrow: 150cm
6) Seeding	30	(manpower)	- Seed: 4kg - Row: 40cm - Plant density: 16,700 plants/ha
7) Spacing	2	(manpower)	
8) Top dressing -1st	2	(manpower)	- N: 38kg, K_2O: 23kg
Top dressing -2nd	2	(manpower)	- N: 38kg, K_2O: 23kg
9) Application of insecticide -1st	4	- Knapsack-type sprayer	- Insecticide: 1 lit.
Application of insecticide -2nd	4	- Knapsack-type sprayer	- Insecticide: 1 lit.
10) Application of fungicide -1st	4	- Knapsack-type sprayer	- Fungicide: 1 lit.
Application of fungicide -2nd	4	- Knapsack-type sprayer	- Fungicide: 1 lit.
11) Weeding -1st	5	(manpower)	
Weeding -2nd	5	(manpower)	
12) Field maintenance	15	(manpower)	
13) Irrigation	10	(manpower)	
14) Harvesting and hauling	30	(manpower)	
15) Packing and transportation	12	- Oxcart	- Jute bag: 80 nos.
Man-day required	160		

Table V.10 PROPOSED FARMING PRACTICES FOR GROUNDNUTS

Farming Practice	Labour Requirement (man-day)	Machinery and Equipment	Farm Input per Hectare
1) Ploughing	11	- Plough	
2) Basal application of fertilizer	4	(manpower)	- P_2O_5: 40kg, K_2O: 40kg,
3) Harrowing	4		- Twice
4) Ridging	5	- Ridger	- Furrow: 60cm
5) Seeding	4	- Drill seeder	- Seed: 60kg - Row: 15cm - Plant densigy: 110,000 plants/ha
6) Spacing	2	(manpower)	
7) Top dressing	2	(manpower)	- K_2O: 40kg
8) Application of insecticide	4	- Knapsack-type sprayer	- Insecticide: 1 lit.
9) Application of fungicide	4	- Knapsack-type sprayer	- Fungicide: 1 lit.
10) Weeding -1st	5	(manpower)	
Weeding -2nd	5	(manpower)	
11) Field maintenance	15	(manpower)	
12) Irrigation	10	(manpower)	
13) Harvesting and hauling	30	- Threshing machine	
14) Storing	5	(manpower)	
15) Packing and transportation	5	- Oxcaft	- Jute bag: 30 nos.
Man-day required	115		

Table V.11 REQUIREMENT OF FARM INPUTS

Products	Seed (kg/ha)	Fertilizer (kg/ha)			Insecti-cide (lit./ha)	Fungicide (lit./ha)
		N	P_2O_5	K_2O		
1) Paddy	30	120	60	60	3	1
2) Maize	25	105	92	60	1	1
3) Sorghum & millet	8	64	46	36	1	1
4) Tomato	0.4	185	120	210	2	2
5) French beans	100	110	110	150	1	1
6) Other crops						
- Onion	5	105	75	135	2	2
- Potato	1.2(t)	100	100	150	2	2
- Watermelon	2	220	150	190	2	2
- Gombo	4	115	60	70	2	2
- Groundnuts	60	0	40	80	1	1

Table V.12 LABOUR REQUIREMENT FOR PROPOSED FARMING PRACTICES PER HECTARE

(Unit: man-day/ha)

Farming Practice	Paddy	Maize	Sorghum and Millet	Tomato	French Beans	Other Vegetables (Onion)	Ground-nuts
1) Nursery preparation	5	-	-	120	-	120	-
2) Application of compost	-	-	-	10	-	10	-
3) Basal application of fertilizer	4	4	4	4	4	4	4
4) Ploughing	11	11	11	11	11	11	11
5) Weeding -1st	2	2	2	2	2	2	2
Weeding -2nd	-	2	2	2	2	2	2
6) Ridging	-	3	3	2	5	2	5
7) Puddling -1st	3	-	-	-	-	-	-
Puddling -2nd	3	-	-	-	-	-	-
8) Levelling	3	-	-	-	-	-	-
9) Transplanting	35	-	-	80	-	80	-
10) Seeding	-	3	3	-	4	-	4
11) Spacing	-	2	2	-	2	-	2
12) Top dressing -1st	2	2	2	2	2	2	2
Top dressing -2nd	4	2	2	2	-	2	-
Top dressing -3rd	2	-	-	2	-	2	-
Top dressing -4th	-	-	-	2	-	2	-
13) Application of insecticide -1st	4	4	4	4	4	4	4
Application of insecticide -2nd	4	-	-	4	-	4	-
Application of insecticide -3rd	4	-	-	-	-	-	-
14) Application of fungicide -1st	4	4	4	4	4	4	4
Application of fungicide -2nd	-	-	-	4	-	4	-
Application of fungicide -3rd	-	-	-	-	-	-	-
15) Weeding -1st	5	5	5	5	5	5	5
Weeding -2nd	5	5	5	5	5	5	5
Weeding -3rd	5	-	-	5	-	5	-
16) Field maintenance	-	-	-	-	-	-	15
17) Irrigation	10	10	10	10	10	10	10
18) Harvesting and hauling	30	30	30	180	70	110	30
19) Drying and threshing	10	10	10	-	-	-	5/1
20) Packing and transportation	10	6	6	40	10	30	5
Total	165	105	105	500	140	420	115

Remarks: Daily working hours are 6 ha for man and 3 ha for animal.

Table V.13 ANIMAL POWER REQUIREMENT FOR PROPOSED FARMING PRACTICES PER HECTARE

(Unit: hr/ha)

	Farming Practice	Paddy	Maize	Sorghum & Millet	Tomato	French Beans	Other Vegetables	Ground-nuts
1)	Nursery Preparation/2	5	-	-	2	-	2	-
2)	Ploughing/1	33	33	33	33	33	33	33
3)	Harrowing/1 -1st	6	6	6	6	6	6	6
	Harrowing -2nd	-	6	6	6	6	6	6
4)	Ridging/1	-	10	10	7	14	7	14
5)	Puddling/1 -1st	9	-	-	-	-	-	-
	Puddling -2nd	9	-	-	-	-	-	-
6)	Levelling/1	8	-	-	-	-	-	-
7)	Seeding/1	-	10	10	-	14	-	14
8)	Transporting/3							
	- Farm inputs	2	2	2	17	2	17	2
	- Products	12	9	6	75	6	48	5
	Total	84	76	73	146	81	119	80

Remarks: /1: Working capacity of draft animal is calculated according to the following estimation:

Working capacity per hectare = $(\frac{10}{W})/V/F$

where, W: working width (m)
V: working speed (km/hr)
F: efficiency

W, V and F are:

Farming Practice	W (m)	V (km/h)	F
Ploughing	0.25	2.0	0.6
Harrowing	1.10	2.5	0.6
Ridging & Seeding			
- Maize, sorghum and millet	0.80	2.0	0.6
- Tomato	1.20	2.0	0.6
- French beans	0.60	2.0	0.6
- Other vegetables	1.20	2.0	0.6
- Groundnuts	0.60	2.0	0.5
Puddling	1.10	2.0	0.6
Levelling	1.20	2.0	0.5

/2: Rice: {2)+3)+5)+6)} /25 (proportion of nursery bed required/main field
Tomato and other vegetables: {2)+3)+4)+7)} /50

/3: 2 hrs/t

Table V.14 LABOUR AND ANIMAL POWER REQUIREMENT FOR TYPICAL FARM (1.2 HA)

Crop	Area (ha)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Manpower Required (man/day)													
1) Paddy	1.11	0.0	0.0	0.0	0.0	0.8	2.3	1.7	1.1	1.3	1.2	0.7	0.0
2) Maize	0.74	0.3	0.3	0.2	0.3	1.0	0.1	0.0	0.0	0.0	0.0	0.1	0.6
3) Sorghum & millet	0.09	-/1	-	-	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-
4) Tomato	0.16	0.8	0.6	0.4	0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.4	0.4
5) French beans	0.05	0.1	0.1	-	0.0	0.0	0.0	0.0	0.0	-	-	-	0.1
6) Other vegetables	0.25	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.8	0.7
Total	2.40	1.8	1.6	1.1	1.3	2.5	2.9	2.2	1.6	1.8	2.1	2.1	1.8
Man-day available		4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Animal Power Required (hr/day)													
1) Paddy	1.11	0.0	0.0	0.0	0.0	1.1	2.3	0.7	-	0.1	0.3	0.2	-
2) Maize	0.74	0.2	-	-	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.3	1.4
3) Sorghum & millet	0.09	-	0.0	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.2	-
4) Tomato	0.16	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1
5) French beans	0.05	-	-	-	0.0	0.0	0.0	0.0	0.0	-	-	-	-
6) Other vegetables	0.25	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2
Total	2.40	0.6	0.3	0.3	0.4	1.6	2.5	0.9	0.2	0.3	0.7	1.1	1.7
Animal power available		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

Remarks: /1: Regligeble

Table V.15 CROP PRODUCTION IN CASES OF "WITH" AND "WITHOUT" PROJECT

Crop	With Project			Without Project			Increased Production
	Planted Area (ha)	Unit Yield (t/ha)	Production (t)	Planted Area (ha)	Unit Yield (t/ha)	Production (t)	(t)
Paddy	2,400	4.0	9,600	280	1.4	390	9,210
Maize	1,600	3.0	4,800	220	1.1	240	4,560
Sorghum and millet	200	2.0	400	230	0.7	160	240
Tomato	350	25.0	8,750	150	11.8	1,770	6,980
French beans	150	2.0	300	-	-	-	300
Onion	100	25.0	2,500	80	21.5	1,720	780
Potato	100	8.0	800	-	-	-	800
Watermelon	100	20.0	2,000	-	-	-	2,000
Okura	100	4.0	400	-	-	-	400
Groundnuts	100	1.5	150	10	0.6	10	150
Fodder crops	400	93.0	37,200	-	-	-	37,200

Table V.16 FRESH MILK RECEIVED AND MILK PROCESSED BY ULB

Year	Raw Milk Collected		Milk Processed	
	1,000 lit./y	lit./day	1,000 lit./y	lit./day
1970	60.9	196	476.6	1,537
1971	314.4	1,014	722.9	2,332
1972	375.8	1,212	1,033.8	3,335
1973	148.6	479	966.9	3,119
1974	291.1	939	1,033.8	3,335
1975	331.9	1,071	1,460.9	4,713
1976	215.2	694	2,180.9	7,035
1977	68.8	222	2,787.5	8,992
1978	83.5	269	3,173.5	10,237
1979	61.6	199	2,638.3	8,511
1980	1.2	4	2,652.9	8,558
1981	1.4	5	3,481.6	11,231
1982	75.9	245	4,365.6	14,083
1983	51.8	167	5,250.1	16,936
1984	154.9	500	6,699.6	21,612
Average	149.1	481	2,595.0	8,371

Source: ULB

Table V.17 MILKING COW REPRODUCTION PROGRAMME

(Unit: heads)

Designation	Year 1	2	3	4	5	6	7	8
1) Cows for breeding purposes	280 (220)/1	280 (440)	280 (660)	-	-	-	-	-
2) Number of birth	180	350	600	720	920	1,170	1,170	1,170
3) Number of females	90	180	300	360	460	580	580	580
4) Reared calves	90	180	300	360	250	250	250	250
5) Death rate among the less than one-year of age	0	10	10	10	20	10	10	10
6) Weaned calves	-	90	170	290	340	240	240	240
7) Death rate among the 1-2 years of age and 2-3 years of age	-	10	10	10	20	10	20	20
8) Reared heifers	-	-	80	160	270	330	220	220
9) Selected barren females	-	-	0	0	10	10	20	10
10) Cows in milk at first calving	-	-	-	80	150	260	310	210
11) Cows in milk in total	220	440	660	740/2	890	1,150	1,460	1,460
12) ♂ calves on sale	90	180	300	360	460	580	580	580
13) ♀ calves on sale	0	0	0	0	210/3	330	330	330
14) Barren cows on sale	0	0	0	0	10	10	20	10
15) Cast cows	0	0	0	0	0	0	0	210

Remarks: ♀ : Females, ♂ : Males

/1: Death rate (20%): 280 x 0.8 = 220

/2: Total number of cows in milk = Number during the preceding year + Number during the present year: >40 = 600 + 800

/3: Number of ♀ calves on sale = Number of born ♀ calves - Number of reared ♀ calves: 210 = 460 - 250

Table V.18 EXPECTED ANNUAL MILK PRODUCTION BY BREED

Breed	Weight/1 (kg)	Milk Production (lit.)/2	
		Minimum	Maximum
Montbéliard x N'dama	450	1,500	2,800
Rouge des Steppes x N'dama	450	1,200	2,500
Jersey x N'dama	250 - 350	1,200	2,500

Remarks: /1: 3 to 4 years in age
/2: 290 days for lactation

Source: National Animal Husbandary Research Center in Sotuba

Table V.19 ANNUAL MILK AND MEAT PRODUCTION

Year	Number of Milking Cows (heads)	Milk Production			Meat Production	
		Total Production (10^3 lit.)	Milk taken by Calves (10^3 lit.)	Milk for Sale (10^3 lit.)	Cows weeded Out (head)	Male Calves (head)
1	220	440	50	390	0	90
2	440	880	90	790	0	180
3	660	1,320	150	1,170	0	300
4	740	1,480	170	1,310	0	360
5	890	1,780	120	1,660	10	670
6	1,150	2,300	120	2,180	10	910
7	1,460	2,920	120	2,800	30	910
8	1,460	2,920	120	2,800	220	910
:	:	:	:	:	:	:
:	:	:	:	:	:	:
:	:	:	:	:	:	:
Onward						

Table V.20 FODDER CROPS RETAIRED IN BAGUINEDA

Varieties	Yield (t/ha)
1) Graminaceae	
- Andropogon gayanus	50
- Brachiaria ruziziensis	30
- Brachiaria mutica	50
- Cenchrus ciliaris	20
- Echinochloa stagnina	100
- Panicum maximum	100
- Pennisetum purpureum	130
2) Leguminous plants	
- Dolichos lablab	30
- Macroptilium atropurpureum	30
- Stylosanthes hamata	15
- Stylasanthes humilis	15
- Stylosanthes guyanensis	40

Source: National Animal Husbandry Research Center in Sotuba

Table V.21 PROPOSED FARMING PRACTICES FOR FODDER CROPS

Farming Practice	Farm Machinery or Equipment	Tractor Required (HP)	Remarks
Application of Compost	Manure spreader	60	3 tons at maximum
Ploughing	Disc plough	60	20" x 3 depth: 15-20 cm
Harrowing	Disc harrow	60	20" x 20
Seeding Fertilization	Fertilizer spreader	45	16 rows Fertilizer: 1.38 t/ha Seed: 14 kg/ha
Seed Packing	Cambridge roller	45	Direct cutting: 1.35 m wide
Harvesting	Mowing-hatching-loading machine	45	
Transporting	Trailer	45	3 tons at maximum
Fertilization and additional Seeding	Seeder	45	400 lit., 6 times per year

Table V.22 FODDER COMPOSITION

Designation	Time	Vegetating Period (weeks)	Dry Matter (%)	Fodder Unit (UF/MS)	Digestible Nitrogenous Material (g/kg.MS)
I) Graminaceae					
- Panicum maximum	Rainy season	4	17.4	0.62	110
		5	18.9	0.55	91
		6	20.0	0.49	57
		8	23.8	0.47	39
		12	27.8	0.36	0
	Dry season	4	17.4	0.57	100
		5	18.1	0.53	58
		6	17.9	0.50	40
		8	19.8	0.40	27
- Echinochloa stagnina	Dry season	6	20.7	0.56	109
- Pennisetum purpureum	Rainy season	5	16.8	0.62	85
		7	16.4	0.61	65
		9	18.3	0.49	27
		14	19.1	0.46	0
	Dry season	5	15.0	0.62	110
		6	15.9	0.61	69
		8	15.4	0.52	47
		12	16.4	0.51	24
II) Leguminous Plants					
- Stylosanthes guyanensis	Rainy season	6	21.0	0.74	154
		8	22.1	0.73	134
		10	22.3	0.71	109
	Dry season	6	23.0	0.74	133
		8	24.4	0.73	112
		10	33.4	0.64	99

Remarks: M.S.: Dry matters
M.A.D.: Digestible nitrogeneous materials
U.F.: Fodder units

Source: Mémento de l'Agronome, Ministère de la Coopération, République Francaise

Table V.23 EXPECTED FODDER YIELD AND PRODUCTION

Varieties	Yield (t/ha)	Dry Matters (%)	Fodder Value (kg/MS)		Production	
			Kg of Dry Matters	Fodder Unit	Kg of Dry Matters	Fodder Unit
Panicum maximum	100	21.8	0.033	0.44	719	9,592
Echinochloa stagnina	100	20.7	0.109	0.56	2,256	11,592
Pennisetum purpurem	130	15.9	0.056	0.57	1,158	11,782
Stylosanthes guyanensis	40	23.3	0.123	0.73	1,146	6,804
Average	93	20.4			1,320	9,940

Table V.24 TYPICAL ENERGY VALUE REQUIREMENTS FOR MILKING COW

Feed Composition	Maintenance	Growth	Last 3 Months of Pregnancy	Location	Work[/1]	Fattening
Feed Unit (UF)	Body weight / Requirement 100kg: 1.2 150kg: 1.6 200kg: 2.0 250kg: 2.3 300kg: 2.6 400kg: 3.2 500kg: 3.8	Per kg of gain at birth 6-12 months: 2.1 12-18 months: 2.7 18-24 months: 3.0 24-36 months: 3.2	7th month: 0.1/100kg of live weight 8th month: 0.2/100kg of live weight 9th month: 0.3/100kg of live weight	0.38 per kg of milk at 4% of butter fat	Total requirement (maintenance E + work) light work: $\frac{3E}{2}$ medium : 2E heavy : $\frac{5E}{2}$	Per kg of gain beginning: 3.0 middle: 3.5-4.0 end: 4 to 5
Protein (digestable)	0.6g/day/kg live weight	Total requirement at birth : 130-140g/UF 6-12 months: 100-130 12-18 months: 80-100 18- months: <80	100g/UF	60g/kg of milk at 4% of butter fat	Heavy to medium work: 0.8g/kg of live weight	Total requirement according to age: 80 to 120g/UF
Vitamin - Vit.A	20,000 IU/day per 100kg/of live weight	20,000 IU/day per 100g of live weight	13,000 IU/day	30,000 IU/day per 100kg of live weight		
- Vit.D		Per 100kg of live weight Calves: 880 IU/day Young: 220 IU/day	800 IU for 100kg of live weight	800 to 1,000 IU for 100kg of live weight		
For Calves - Vit.B_1	3mg/100kg of live weight	4 to 5mg/100kg of live weight				
- Vit.B_2	2mg/100kg of live weight	3mg/100kg of live weight				
Calcium	5g/100kg of live weight	15 to 25g/kg of gain	6g/100kg of live weight	3g/kg of milk		
Phosphorus	3g/100kg of live weight	10 to 20g/kg of gain	5.5g/100kg of live weight	1.5g/kg of milk		
NaCl	5g/100kg of live weight	2g/kg of gain		2.0g/kg of milk		

Remarks: /1: The growth of energy expenditure is estimated at 0.42 calory per km travelled and per kg of live weight: 0.022 FU for 100kg of live weight per km travelled.
/2: International unit
Source: Memento de L'Agronome, Ministère de la Cooperation, Republique Francaise

Table V.25 ANNUAL ENERGY VALUE REQUIREMENTS FOR MILKING COW REARING

	Ages in Months	Number of Cows	Feeding Type	Feeding Period (days)	Daily Needs		Annual Needs	
					Fodder Unit	Digestible Nitrogeneous Materials (kg)	Fodder Unit	Digestible Nitrogeneous Materials (kg)
1)	Cows in milk (more than 37 months)	1,460	Maintenance	365	2.9	0.21 /2	1,545	112
2)	Cows in milk (more than 37 months)	1,460	Suckling	240 /4	3.5 /3	0.56	1,226	196
3)	Cows in milk (more than 37 months)	1,460	Pregnancy /1	72 /5	0.7	0.07	74	7
4)	Calves (1 to 6 months)	240	Growth	180	1.7 /6	0.23	73	10
5)	Calves (7 to 12 months)	240	Growth	185	2.5	0.29	111	13
6)	Heifers (13 to 18 months)	220	Growth	180	3.0	0.27	119	11
7)	Heifers (19 to 24 months)	220	Growth	185	3.3	0.26	134	11
8)	Cows at first calving	220	Growth	365	3.1	0.25	249	20
9)	Cows at first calving	220	Pregnancy /1	90	0.7	0.07	14	1
	Total						3,545	381

Remarks: /1: Pregnancy: last 3 months (90 days)

/2: 0.gg per kg of live weight x 350 kg = 0.21 kg

/3: Milk production with 4% of fat matters = $\frac{4.5\% \times 2,500 \text{ lit.}}{4\%}$ = 2,800 lit.

Energy requirement in fodder unit/day for milk production (fat matters 4%) = $\frac{2,800 \text{ lit.} \times 0.38}{300 \text{ days}}$ = 3.5 fodder unit/day

/4: Period of location: 300 days

Mean annual period of location = 300 days x $\frac{12 \text{ months}}{15 \text{ months}}$ = 240 days

/5: Mean annual period of the last 3 months of pregnancy = 90 days x $\frac{12 \text{ months}}{15 \text{ months}}$ = 72 days

/6: Fodder unit for maintenance x 0.5 kg/day = 0.8 fodder unit/day

Fodder unit for maintenance: 0.9 fodder unit/day for 65 kg of live weight

Total needs for fodder unit for growth: 0.8 fodder unit/day + 0.9 fodder unit/day = 1.7 fodder unit/day

Table V.26 AVERAGE EFFICIENCY OF AGRICULTURAL MACHINERY

	Agricultural Machinery	Capacity	Average Efficiency ha/h	h/ha
1)	Manure spreader	2.2 m^3	0.19	5.3
2)	Disc plough	26" x 3 rangs	0.29	3.4
3)	Disc harrow	18" x 24 rangs	0.80	1.3
4)	Fertilizer spreader	16 rangs	0.83	1.2
5)	Cambridge type roller	2.4 m	0.78	1.3
6)	Fodder harvester (Ventilating type)	1.5 m	0.43	2.3
7)	Fodder trailer	3 t	2.5 t/h	
8)	Seeder	400 lit.	1.20	0.8

Table V.27 AGRICULTURAL MACHINERY REQUIRED FOR FODDER CULTIVATION

Designation	H.P. (CV)	Number to be Used (times)	Work Quantity (ha/year)	Efficiency (ha/day)	Length of Work (hours/day)	Necessary Number
1) Tractor						
- Tractor	60				5.9	2
- Tractor	45				90.3	11
2) Conversion equipment items and accessories						
- Manure spreader	60	1	130	0.5	2.7	1
- Disc plough	60	1	130	0.5	1.9	1
- Disc harrow	60	2	270	1.0	1.3	1
- Fertilizer spreader	45	1	130	0.5	0.6	1
- Cambridge type roller	45	1	130	0.5	0.6	1
- Moving hatching machine	45	6	2,400	9.4	21.6	3
- Fodder trailer	45	6	37,200 t/1	146 t	58.4/2	6
- Seeder	45	6	2,400	9.4	7.5	2

Remarks: /1: Total fodder production per year: 95 t/ha x 400 ha = 37,200 t

/2: Including time required for transporting between a given pasture and cow stable.

Table V.28 PRODUCTION AND IMPORT OF CEREALS IN MALI

(Unit: 1,000 t)

Product	1978	1979	1980	1981	1982	Average
Production/1						
Millet	552	350	420	538	629	498
Sorghum	358	396	289	412	427	376
Rice/3	103	156	86	88	91	107
Maize	103	76	45	61	89	75
Wheat/4	39	17	26	49	24	31
Sub-total	1,155	995	866	1,148	1,268	1,087
Import/2						
Wheat	25	12	22	32	38	26
Rice	21	24	53	24	71	39
Maize	17	0	6	32	33	18
Other cereals	7	4	8	9	14	8
Sub-total	70	40	89	97	156	91
Total (1) + (2)	1,225	1,035	955	1,245	1,424	1,178

Remarks: /1: Repport de L'enquete Agricolo 1982-1983

/2: FAO Trade Year Book (Vol. 34-36)

/3: Calculated based on the volume of paddy with 0.65 of milling rate

/4: Wheat and wheat flour in wheat equivalent

Table V.29 Per Capita Consumption of Cereals IN MALI

Year	Production (10^3 t)		Imported (10^3 t)		Total (10^3 t)		Population (10^3)	Per Capita Consumption (kg/year)		
	Cereals/1	Rice	Cereals/1	Rice	Cereals/1	Rice		Celears/1	Rice	Total
1978	1,107	103	49	21	1,156	124	6,690	172.8	18.5	191.3
1979	923	156	16	24	939	180	6,786	138.4	26.5	164.9
1980	826	86	36	53	862	139	6,947	124.1	20.0	144.1
1981	1,107	88	73	24	1,180	112	7,111	165.9	15.8	181.7
1982	1,223	99	85	71	1,308	170	7,280	179.7	23.4	203.0
Average	1,037	106	52	39	1,089	145	6,963	156.2	20.8	177.0

Remarks: /1: Other cereals except for rice

Table V.30 PROJECTION OF TOTAL DEMAND OF CEREALS

Year	Population (10^3) (1)	Per Capita Consumption (kg/year) Cereals/1 (2)	Rice (3)	Total Demand (10^3 t) Cereals/1 (4)=(1)x(2)	Rice (5)=(1)x(3)	(Paddy) (6)=(5)/0.65	Total (7)=(4)+(5)
Mali							
1982	7,280	156.2	20.8	1,137	151	(233)	1,289
1985	8,003	157.1	22.1	1,258	177	(272)	1,435
1990	9,055	158.7	24.4	1,437	221	(339)	1,658
1995	10,245	160.3	26.9	1,642	276	(424)	1,918
2000	11,591	161.9	29.7	1,877	344	(530)	2,221
Bamako							
1985	680	157.1	22.1	107	15	(23)	122
1990	759	158.7	24.4	122	19	(29)	141
1995	870	160.3	26.9	140	23	(36)	163
2000	985	161.9	29.7	159	29	(45)	189

Remarks: /1: Other cereals except for rice

Table V.31 MARKETABLE CEREALS FROM PROJECT AREA

Year	Population/1	Consumption per Inhabitant (kg)		Total Consumption in Project Area (t)		From the Project (t)		Marketable Quantity (t)	
		Rice	Cereals/2	Rice	Cereals/2	Rice	Cereals/2	Rice	Cereals/2
1985	18,000	22.1	157.1	400	2,800	-	-	-	-
1990	20,400	24.4	158.7	500	3,200	6,240/3	5,600	5,740	2,400
1995	23,000	26.9	160.3	620	3,700	6,240	5,600	5,620	1,900
2000	26,000	29.7	161.9	770	4,200	6,240	5,600	5,470	1,400

Remarks: /1: Population growth rate: 2.5% per year

/2: Cereals comprise maize, millet and sorghum

/3: Milling rate: 9,600 x 0.65

Table V.32 ECONOMIC PRICES OF FARM PRODUCTS

	Farm Products	Unit	Unit Price (FCFA)
1)	Crop Products		
	- Rice	kg	204
	- Paddy	kg	141
	- Maize	kg	124
	- Sorghum/millet	kg	123
	- French beans	kg	705
	- Broad beans	kg	238
	- Tomato (dry season)	kg	75
	- Watermelon	kg	60
	- Onion	kg	86
	- Potato	kg	125
	- Okra	kg	167
	- Groundnuts	kg	230
	- Mango	kg	170
2)	Animal products		
	- Milk (fresh)	lit.	238
	- Meat (cattle 400 kg)	kg	220

Table V.33 ECONOMIC PRICES OF FARM INPUTS AND EQUIPMENT

Item	Unit	Unit Price (FCFA)
1) Seed		
- Paddy	kg	141
- Maize	kg	124
- Sorghum/millet	kg	123
- French beans	kg	2,000
- Tomato	kg	12,000
- Watermelon	kg	6,000
- Onion	kg	9,600
- Potato	kg	140
- Okra	kg	6,000
- Groundnuts	kg	90
- Fodder crop	kg	900
2) Fertilizer		
- Urea	kg	128
- TSP	kg	92
- Ammonium phosphate	kg	112
- Potassium cloride	kg	74
3) Agrochemical		
- Insecticide	lit.	1,480
- Fungicide	lit.	2,100
4) Farm Equipment		
- Plough		56,600
- Tooth harrow		5,800
- Puddling rake		5,700
- Levelling board		800
- Ridger		5,000
- Drill seeder		37,000
- Knapsack-type sprayer		49,300
- Rotary weeder		8,800
- Pedal thresher		126,200
- Winnower		86,800
- Corn sheller		15,600
- Oxcart (1 t)		45,300

Table V.34 ESTIMATION OF ECONOMIC PRICES OF FARM PRODUCTS

(Unit: F CFA/kg)

Item	Rice	Paddy	Maize	Sorghum/ Millet
1) International market price				
(US$/t)/1	319/3	-	110/4	106/4
(F CFA/kg)/2	140	-	48	47
2) Freight	40	-	40	40
3) CIF Abidjan	180	180	88	87
4) Port charge, etc.	10	10	5	5
5) Inland transportation				
Abidjan - Baguineda	31	31	31	31
6) Milling charge	-	3	-	-
7) Project site price	204/5	141/6	124	123

Remarks: /1: Projected price for 1995 base on 1985 constant US$.

/2: US$1 = 440 F CFA

/3: FOB Bangkok, broken rice 5%

/4: FOB Port Gulf

/5: Quality down due to 25% of broken rice

$$221 \text{ F CFA/kg} \times \frac{160 \text{ F CFA/kg (25\% broken)}}{175 \text{ F CFA/kg}}$$

/6: 221 F CFA/kg x 0.65 - 3 F CFA/kg = 141 F CFA/kg

Table V.35 TOTAL REQUIREMENT OF AGRICULTURAL CREDIT

Item	New Installation/1		Re-installation/2		Grand Total
	10^3 F CFA/ Family	Total (10^6 F CFA)	10^3 F CFA/ Family	Total (10^6 F CFA)	
1) Housing (40 m^2)	115	148	-	-	148
2) A Pair of Oxen/3	200	258	-	-	258
3) Farm Equipment	446	575	446	391	966
Plough	57	-	57	-	-
Tooth harrow	6	-	6	-	-
Puddling rake	6	-	6	-	-
Levelling board	1	-	1	-	-
Ridger	5	-	5	-	-
Drill seeder	37	-	37	-	-
Knapsack-type sprayer	49	-	49	-	-
Rotary weeder	9	-	9	-	-
Pedal thresher	126	-	126	-	-
Winnower	89	-	89	-	-
Corn sheller	16	-	16	-	-
Oxcart	45	-	45	-	-

Remarks: /1: Newly transmigrated from outside: 1,288 families

/2: Resettled: 877 families

/3: 2 oxen x 100,000 F CFA: 200,000 F CFA