(9) Design Unit Water Requirement

The design unit water requirements, which are set up as 24 or 18 hour successive irrigation, are calculated on the basis of the above-mentioned basic values not taking into consideration the effective rainfall. The results are as shown below.

(a) Development Plan for the N'Zi River Main Course

i) Option - 1

- Peak Irrigation Hours : 24 hours
- Soil Type : Loam - Clay
- Design Unit Water Requirement : 1.49 lit/sec/ha (Table F-4 in Annex F)

ii) Option - 2 & Option - 3

- Peak Irrigation Hours : 24 hours
- Soil Type : Loam - Clay
- Design Unit Water Requirement : 1.55 lit/sec/ha (Table F-4 in Annex F)

(b) Development Plan for Tributaries of the N'Zi River

i) Loam - Clay Area

- Peak Irrigation Hours : 18 hours
- Design Unit Water Requirement : 2.07 lit/sec/ha (Table F-4 in Annex F)

ii) Sandy Soil Area

- Peak Irrigation Hours : 18 hours
- Design Unit Water Requirement : 2.75 lit/sec/ha (Table F-4 in Annex F)

4-3-4 Concept for Irrigated Agriculture Development

As mentioned in the section 4-3-2, four types of irrigated agriculture development, namely three types using water of the N'Zi main river and one type of schemes using water of tributaries, are technically feasible in the study area. (See Table 4-3-2) Among four types, the type of option 3 with construction of a large-sized dam in the main river is to exploit almost full potential water resources of the N'Zi main river to develop 29,200 hectares of irrigated agriculture, whose economical efficiency is relatively justifiable. However, implementation of this case has such difficulties as given below because of its large size of development: 1) it will be almost impossible to organize and support more than 30 or 40 thousands farmers in a short period, who are not at all familiar with irrigated agriculture, so that they will manage to successfully conduct operation and maintenance of irrigation

facilities and modernized farming; and, 2) implementation of this option needs a considerable amount of fund at a time. Accordingly, it is recommended to implement the large-sized development at the final stage of development in the study area, when farmers and people concerned become experienced with irrigated agriculture after small-sized schemes have step by step been implemented.

The other three types of development are all of small-sized schemes, which can be implemented one by one steadily extending supporting services to farmers for establishment of stable irrigated agriculture. Among those three types, the type of tributary development schemes has the following advantages: 1) the schemes are of relatively high economic viability; and 2) it is the most viable for farmers inexperienced with irrigated agriculture to manage it, because operation and maintenance of this type of schemes with gravitational irrigation, is easy and inexpensive. Accordingly, among the schemes, implementation of those justified from viewpoints of economic viability, soil suitability, existence of participating farmers in the vicinity and environmental impacts is of priority.

The type of option 1 schemes taking irrigation water from the N'Zi main river will function as a part of the intaking and irrigating system with a upstream large dam, when the project of the option 3 is realized. In case of the type 2, low dams will work as regulating and supplementary reservoirs for the upstream large reservoir. Compared with the type 4 with gravitational irrigation, the types 1 and 2 have some difficulties on maintenance and operation of pumping equipment included in those schemes and need mechanical skill, appropriate repairing in time of troubles and a considerable amount of operation cost for energy and personnel to be borne by farmers. Accordingly, the types 1 and 2 are considered to be in general given less priority than schemes of relatively more favorable conditions such as the type 4 schemes. However, due to the presence of remote villages from the sites concerned by the tributaries development, it is proposed to gradually implement such a development targeting areas where farmers show enough willingness for it and where conditions such as economical viability, soil suitability and access are advantageous.

Table 4-3-2 Irrigation development system in the study area

Items	Irrigation development along the N'Zi main stream			Irrigation development along the N'Zi' tributaries
	(1) Pumping without control of the flow by dams	(2) Pumping with control of the flow by small dams built on the minor bed	(3) Construction of a large dam upstream for the purpose of irrigation, flood control and pumping downstream	(4) Construction of small dams on the tributaries for the purpose of irrigation and flood control
Potential development area (ha)	5,150	4,950	29,200	4,635
Scale of development	Small, about 250 ha/area	Small, about 500 ha/area	Very big, 29.200 ha	20-1590 ha/area, most of the areas have less than 300 ha, hence small size
Approximate cost of the project (million CFAF)	51,230	65,570	361,230	99,312
Economic Internal Rate of Return (%)	7.4	8.3	7.6	less than 11.4, with each area having a different rate
Single or double cropping a year	Single cropping in the rainy season	Double cropping, in rainy season and dry season	Double cropping, in rainy season and dry season	Double cropping, in rainy season and dry season
Operation and management of installations	fairly difficult due to the use of pumps and the relatively high operation costs	fairly difficult due to the use of pumps and the relatively high operation costs	Very complex large scale system. Fairly difficult due to the use of pumps and the relatively high operation costs.	Simple gravity irrigation system with easy operation and management. Relatively low maintenance and management costs.

Development sites to be included in the Master Plan were selected among technically feasible ones of type 1, 2 and 4 in Table 4-3-3, considering the optimum development size and the following conditions of each site:

A) Economical viability; evaluated based on economical internal rates of return obtained from costs (construction and operation & maintenance costs of irrigation and drainage facilities, on-farm works and farm roads) and benefits (from income and expenditure of farming).

B) Soil suitability for irrigated agriculture; classified 1 (most suitable), 2 (suitable), 3 (marginally suitable) and 4 (unsuitable).

C) Existence of potential participating farmers; presence of villages with population large enough to provide participants to planned irrigated agriculture and proximity of such villages to the development site.

D) Environmental impacts; whether the planned reservoir will submerge either a classified forest , a trunk road or a village or not

The results of study for selection of development sites to be included in the Master Plan is shown in Table 4-3-3. For the type 4 of tributary dam development schemes, 17 sites, other than those of unfavorable conditions with "C" rating, were selected. As for pump-irrigated schemes along the N'Zi main stream, two sites, M'Bahiakro and Bocanda, were selected as development sites in the table, because they have most favorable conditions on living of participating farmers and access to market being situated in the neighborhood of M'Bahiakro town or Bocanda town as well as they have consolidated lands to be developed. The types of development involve an annual double cropping system which makes it possible for farmers to work all the year round and secure more income.

Table 4-3-3 Selection of priority development areas

Water stream		Scale of development (ha)	Cost of investment (Million CFA F)	Criteria of selection of the priority development areas							Total evaluation	
				Economic viability (EIRR %)		Soil condition	No Villages		Environment	obstacles		
Right-bank tributaries of the N'Zi (irrigation area: 1,620 ha)												
1	Yabue N'zue	160	10,707	C	-0.4	B	C	0	A	A	C	
2	Sounglou	270	8,793	C	2.8	B	C	0	A	A	C	
3	Toualakoun	95	7,461	C	-1.0	B	C	0	A	A	C	
4	Seke Gloulouha	260	3,660	A	7.8	B	B	2	A	A	A	O
5	Katie	500	5,060	A	11.4	B	C	1	A	A	B	O
6	Mandia	110	8,650	C	-0.9	B	B	1	A	A	C	
7	Mo	60	798	A	8.1	A	A	2	A	C	B	O
8	Akpobo	35	2,335	C	-0.3	A	A	5	A	A	C	
9	Dienzou	110	2,120	B	4.6	A	A	2	A	A	A	@
10	Djamala	40	2,425	C	0	A	A	4	A	A	C	
Left- bank tributaries of the N'Zi (irrigation area: 2.945 ha)												
11	Baa	1590	16,292	A	10.4	A	A	5	A	A	A	O
12	Yanmon	80	1,779	B	3.8	A	A	3	A	A	A	@
13	Pokoukla N'zueba	40	602	A	7.2	A	A	3	A	C	B	O
14	Bassia	40	1,506	C	2.0	A	A	2	C	C	C	
15	Sokpa Yanmien	75	3,357	C	1.4	A	A	4	A	A	C	
16	Abode	80	1,464	B	6.2	A	A	1	A	A	A	O
17	N'blinzueba	40	824	B	5.0	A	A	2	A	A	A	O
18	Baya	200	2,405	A	9.0	A	A	4	A	A	A	O
19	Baa	35	1,486	C	1.6	A	C	0	A	A	C	
20	N'Ziminou	70	936	A	7.8	A	B	1	A	A	A	O
21	Eholie	130	2,655	B	4.3	A	A	2	A	A	A	@
22	Boudasse	120	2,199	B	5.8	A	B	1	A	C	B	O
23	N'diti	20	278	B	6.2	A	C	0	A	A	B	O
24	Kpokla	40	1,843	C	1.1	A	C	0	A	A	C	
25	Atofou	200	3,303	B	6.0	A	A	2	A	A	A	@
26	Damin	160	3,580	B	4.7	A	A	2	A	A	A	O
27	Songan	50	2,070	C	1.8	A	A	1	C	A	C	
28	Ebimolo	25	724	B	3.2	A	A	1	A	A	B	O
Along the main stream of the N'Zi (irrigation area: 932 ha)												
29	M'Bahiakro	453	5,741	A	7.5	A	A	City	A	A	A	@
30	Bocanda	500	6,540	A	8.3	A	A	City	A	A	A	O

(Note)

1) Selection criteria

O: Priority development areas

@: Priority development areas included in the Feasibility Study

Evaluation: A: Good B: Fair C: Poor

Economic viability: A: EIRR greater than 7% B: EIRR 3 - 7% C: EIRR less than 3%

soil conditions: A: Suitability to irrigation 1 (most suitable)

B: Suitability to irrigation 2 (suitable)

Number of villages: A: sufficient labor force

B: labor force relatively sufficient(population)

C: problem in labor force

Protection of environment: A: except B and C

B: proximity of protected forest in the area planned for development

C: presence of protected forest in the area planned for development

Obstacles: A: except C

C: submergence of main roads and villages neighboring the reservoirs

2) Constraints in determining the development scale

For 18 Baya ; 19 Baa ; 20 N'Ziminou, the scale of development depends on the available land resources. For the other areas, the scale of development depends on the available water resources.

3) The priority development areas included in the Feasibility Study are designed by @ (see Chap. 5, 5-5-1)

4) The areas included in the Master Plan Study are designed by o

4-3-5 Drainage Plan

Drainage facilities are planned to prevent crops from being damaged by flood water flowing in from outside of the development area and by inundation caused by rain as well as to control water conditions on fields necessary for crop growing.

(1) Design Drainage Discharge

The design drainage discharge for the paddy field is decided so as to remove 10 years return period 3 days successive rainfall within 3 days, and that for the upland is decided so as to remove 10 years return period daily maximum rainfall within 1 day. The calculated results are as follows ;

- Paddy Field : 4.9 lit/sec/ha
- Upland : 11.6 lit/sec/ha

As the cropland use is planned to be 80 % for paddy field and 20 % for upland, the design inner unit drainage discharge is to be the weighted average value.

- Design Inner Unit Drainage Discharge : 6.24 lit/sec/ha

(2) Drainage Facilities

The drainage canal network to drain surplus water from the croplands to the outside is composed of main drain, collecting drain, field drain and also catch drain to remove flow from the outer area. Some drainage canals, in particular main drain, take advantage of the natural streams.

4-4 Rural Infrastructure

With regard to the infrastructure for people's living in villages in the Study area, only one well with a manual pump or two are equipped for villagers' drinking water in each village, electricity and telephones have not been introduced in most villages, and health care facilities are not satisfactorily available. As these facts imply, the infrastructure in the rural area remains significantly underdeveloped compared with that in the urban area in this

country, reflecting the very low level of production and income in the rural area. Under these circumstances, it is not practical to at once upgrade rural infrastructure, which needs construction and operation costs unbecoming to the income level. Therefore, improvement of rural infrastructure should be planned to concentrate on restricted elements, which are either effective both for agricultural development and better living convenience or indispensable for villagers' daily lives. From this viewpoint, improvement of rural roads and village water supply were taken up for the plan of rural infrastructure.

(1) Improvement of Rural Roads

It goes without saying that the road is one of the most important infrastructures for transportation of increased products and materials through agricultural development and goods for Villagers' living as well as for access of people for education, health care and administration.

Trunk roads and most of feeder roads in the Study area maintain relatively good practicability as described in the section 3-2-2. On the other hand, most of rural roads lose practicability by inundation due to heavy rain because of lack of drainage facilities and gravel pavement. Therefore, it is desirable to improve them to secure traffic during the rainy season.

With regard to road improvement, it is justified from the viewpoint of investment effect to improve routes and/or sections needed to secure increased traffics responding to the agricultural development. Accordingly, improvement of sections of existing roads and construction of new roads necessary for access to cultivated lands are planned for the Master Plan. In general, construction of new roads are of higher priority than the improvement of existing roads. The norm of road structure as shown below is planned to be of rural road (C) with 6 m width according to the existing criteria of Côte D' Ivoire, considering the required function. The road improvement plan is shown in Table 4-4-1.

Classification	Feeder road (A) (more than 50 vehicles a day)	Feeder road (B) (less than 50 vehicles a day)	Rural road (C)
Total width (m)	9.0	7.0	6.0
Thickness of gravel pavement (m)	0.15	0.15	0.15

(2) Village Water Supply

Drinking water is indispensable for villagers' living. Each village is equipped with at least a well with a manual pump, which can supply clean water. Accordingly, in the Study area, for villages where the number of wells do not reach the norm of METT, additional installment of wells to satisfy it is planned. The norm requires that one drilled well with a manual pump be equipped for a village of 100 to 600 inhabitants and one additional well for every additional 400 inhabitants The plan of village water supply is shown in Table 4-4-2.

Table 4-4-1 Road improvement plan

Districts	Routes	Length (km)			No. of
		Existing	New	Total	Culverts
N'Zi main stream					
M'Bahiakro	M'Bahiakro City - Farm	2.1		2.1	1
	Ekloufikro - Farm	1.0	1.0	2.0	
Bocanda	No road is needed				
Right bank of the N'Zi					
Seke Gloulouha	Djenzoukro - Farm		2.0	2.0	-
Katie	Soh Nguessankro - Farm	2.0		2.0	1
Mo	Golikro - Didakoyebo - Farm	4.5		4.5	3
Dienzou	Boore Akpokro - Farm		5.4	5.4	2
	Diangokro - Bangokro - Farm	4.5		4.5	2
Left bank of the N'Zi					
Baa	No Road is needed				
Yanmon	Kouassikro - Farm		3.8	3.8	1
	Abongnikro - Farm	2.2		2.2	1
Pokoukla N'zueba	No road is needed				
Abode	Diakpo - Farm		2.0	2.0	1
N'blinzueba	No road is needed				
Baya	No road is needed				
N'ziminou	Junction - Nziblekro - Farm		0.5	0.5	-
Eholie	Assie Koyekro - Assie Koumassi - Assie Kokore - Farm	1.1	3.8	4.9	
Boudasse	Trunk road - Farm		4.5	4.5	-
N'diti	No road is needed				
Atofou	Kouakro - Farm		4.0	4.0	-
Damin	No road is needed				
Ebimolo		3.0	0.5	3.5	
Total Districts : 18		20.4	27.5	47.9	13

Table 4-4-2 Plan of village water supply (1/2)

	Sub-District	Villages	Population	Water source	Needs	Remarks
				Drilled wells		
Bongouanou	M'Batto	Kouakro	1271	2	2	1 well is intermittent.
		N'Drikro	539	2		
		Yablekro	-		1	
		Adoua-kouakro	1747	2	2	
		Assalekro	1271	1	2	
		Bouafoukro	663	1	1	
	Bongouanou	Assie kokore	1574	3	1	
		Assie Koyekro	625	1	2	1 well is intermittent.
		Assie Koumassi	3579	B -	P -	
		Fronobo	1368	2	2	Village under equipped; 1 well is located far away
		Kinimokro	1025	2	1	
Dimbokro	Bocanda	Abognikro	292	1		
		Gbana Koffikro	228	1	1	
		Klomikro	108	1		
		Siedoukro	-		1	
		Akouassi-kro	761	1	1	
		Assika Kayabo	788	1	1	
		Dida Moessou	851	2	1	to be installed at school
		Guimbo Bayassou	532	1	1	Large village
		Soh N'guessan-kro	-	1	1	New site
		Soussou Yakro	498	1	1	to be installed at school
		Fondi II	-		1	
		Kotokou-nou	-		1	
		Andianou			1	
Total					25	

* The villages underlined are included in the Feasibility Study.

Table 4-4-2 Plan of village water supply (2/2)

Districts	Sub-District	Villages	Population	Water source	Needs	Remarks
				Drilled wells		
Dimbokro	Dimbokro	Kouadjani-kro	365	2		
		Bangokro	774	3		
		Boore Akpokro	692	2	1	
		Boore Ettienkro	584	2	1	
		Bocado	1031	2	1	1 well is intermittent
		Dadie Kouassikro	639	1	1	
		Diangokro	663	2	1	new village
		Soungas-sou	1539	3	1	to be installed at school
		Soungassi	535	1	1	population underestimated
		Tromabo	344	2	1	to be installed at school
Daoukro	Ouelle	Alofo Koffikro	747	1	1	
		Akpanas-sou	696	2	1	population underestimated
		Foutou	308	1	1	
		Gbangbo Tiemelekro	612	1	1	
M'Bahiakro	M'Bahiakro	Aboukro	1074	2	1	
		Kouame Akessekro	1194	2	1	
		Kouassikro	1853	1	1	
		N'Diorekro	906	1	1	
		Kouadio Kouamekro	100		1	
		Zahounkro	717	1	2	1 well is out of order
Total					19	
GRAND TOTAL					44	

* The villages underlined are included in the Feasibility Study.

4-5 Agricultural and Animal Production

The agricultural production programs to be applied to the study area concern two categories of land; irrigated perimeters and rain-fed lands. At any rate, it is supposed that the villages concerned with development project will have both irrigated and rain-fed lands, and that the village people will start animal breeding and fish culture in the project.

4-5-1 Agricultural Production Program in Irrigated Perimeters

Following the policy of the Master Plan of Agricultural Development 1992/2015, the agricultural production program in irrigated perimeters is based on rice culture combined with vegetable production in dry season. At the same time, the program should take into account to improve farmers' income. The program deals with two cases; the perimeters irrigated by gravity utilizing reservoir water on one hand, and the perimeters irrigated by pumping of N'Zi river water on the other.

(1) Perimeters Irrigated by Gravity Utilizing Reservoir Water

Since the irrigation water is available all year round in the perimeters, double cropping of rice and vegetable production in dry season under irrigation would be the major practice here.

Bouake 189 is to be recommended as a rice variety in the irrigated perimeters, as it occupies the first place among rice varieties grown under submerged conditions in North-Central and Central Regions. Because the growth period of this variety is 130 days (Poisson C. and Doumbia S: Variétés Nouvelles de Riz, Nouvelles Editions Africaines, 1987), no constraints will appear to conduct double cropping within a year. The introduction of new varieties like BS 365 or Gulf Mount, however, can be considered in some cases. In the practice of rice double cropping, the following points should be taken into consideration; to save water as much as possible by efficient use of rainfall even in irrigated culture, to meet the harvesting time to sunny months, to facilitate post-harvest operations, and finally, to set sufficient intervals between two cropping seasons to complete cleaning of farm after harvest and soil preparation for the following crop. On the basis of those conditions, the most adaptive cropping calendar will be: seeding at the middle of March and harvest at the end of July for the first crop, and seeding at the middle of September and harvest at the end of January for the second. The type of rice culture is based on direct seeding by broadcast before or after submersion of the field. In case of small-scale farming, however, the hill seeding method would be successfully adopted to save the amount of seeds and to facilitate manual weeding during the season. The proposed cropping calendar involves intervals of 30-40 days between two crops to carry out a series of works necessary for double cropping; harvesting, collect of products, plowing, fertilizer application, submersion of the fields, etc. It is, however, not always easy to complete those works within a month or so. Therefore, the introduction of certain agricultural machines together with the systematic management of works and irrigation by the GVC (Group of cooperative vocation) will be essential.

Recommendable types of agricultural machines are motor cultivators of 12-14 HP

and threshers of around 6 HP if considered the necessary mechanical operations for double cropping. Actually, according to the criteria of the Ivorian Government, existing perimeters including Adahou and Sakassou are equipped with a motor cultivator of 12-14 HP every 10 ha and a thresher of several HP every 20 ha. The rate of double cropping will be 170 % at the initial stage by the consideration of availability of family labor and the efficiency of mechanical operations.

With respect to vegetable culture, tomato and onion are proposed to be main crops, because those two vegetables would be easily accessible to the markets, and would give relatively higher profits. The proposed rotation is 4 years system consisting of Tomato - Onion - Okra - Immature Maize, of which purpose is to prevent unfavorable effects of continuous cropping of the same species (refer to the document; Projet d'amenagement d'un bas-fond pour la riziculture irriguée à Adahou (S/P Dimbokro), CIDV, 1988). Supposing that more profitable off-season production of tomato and onion can be practiced in the perimeters, the growing seasons of these vegetables are fixed as follows: tomato is transplanted in October and harvested from December to February, and onion is transplanted in November and harvested in March. If the proposed rotation consists of single crop culture per year, the possibility of double cropping is not excluded because the introduction of vegetables of short cycle before tomato or onion will be possible if family labor permits it. In the plan, it is assumed that every farmer grows vegetables in their small gardens disposed independently of rice fields as in the manner of traditional vegetable culture in Côte d'Ivoire. In those conditions, watering of vegetables would be carried out by the use of watering cans, taking water from small ponds or farm canals equipped in the perimeter. However, furrow or border irrigation methods using plastic tubes and siphons can be considered if big farmers practice the unique culture of vegetables.

Allotment ratio of irrigated land will be 80 % to rice and 20 % to vegetables. Vegetable production on 20 % of land would be the profitable limit from the viewpoint of present situation of local markets and available family labor.

On the basis of discussions made with the ANADER experts, target yields are fixed as follows: 6 t/ha for rice in both seasons, 30 t/ha for tomato, 30 t/ha for onion, 5 t/ha for okra and 75,000 cobs/ha for immature maize. Yield target of 6 t/ha for rice, though rather higher than that of the Master Plan of Agricultural Development 1992/2015, is to be attained within 5 years subsequent to the completion of construction works, if technical support by the ANADER is as sufficient as the perimeter of Sakassou. The reasons for it is that the latter perimeter has already realized 5 t/ha of yield in the third year after starting of rice culture, and that installation levels in the present project will be superior to those of

Sakassou. Technical guide-line of irrigated rice culture is attached to the Annex (see Annex D-2).

The proposed cropping pattern in the conditions mentioned above is illustrated in Fig. 4-5-1.

By the way, the today's system of rice price is much favored to white rice as compared with unmilled grain, giving rise to big difference in farmers' benefit. Accordingly, it is desirable to equip a small-scale rice mill at every union of GVC from this point of view.

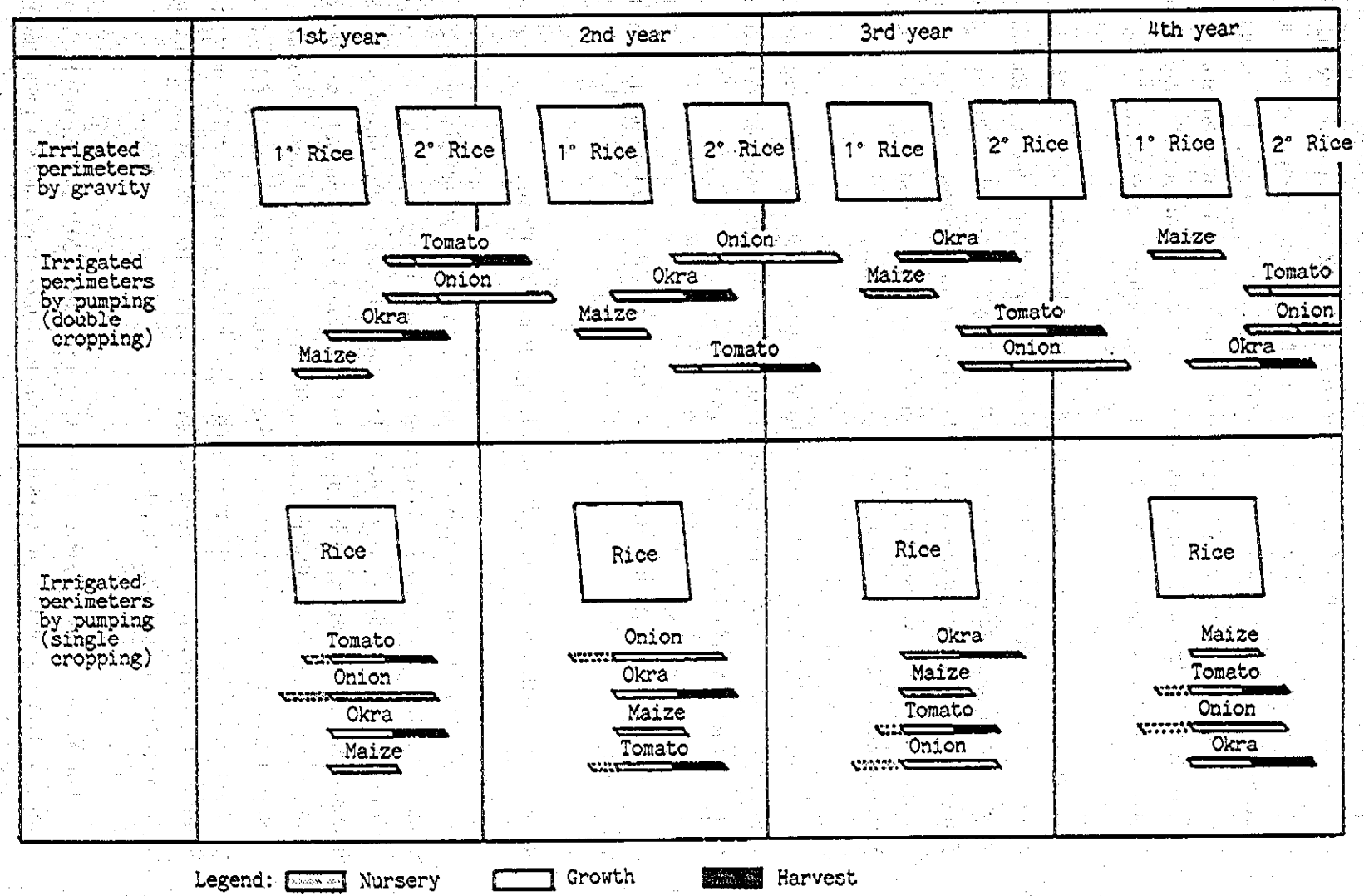
(2) Perimeters Irrigated by Pumping of N'Zi River Water

As the water level of the N'Zi extremely lowers during the period from February to April, the double cropping of rice described before is practically impossible unless the water reserve is realized by the construction of low dam(s) or head-work(s). Therefore, in case of simple pumping of N'Zi river water, the type of crop production would consist of single cropping of rice and vegetable culture in wet season.

On the contrary, if water were to be reserved by the construction of low dam(s) or head-work(s), the double cropping of rice and vegetable production in dry season would be easily introduced, applying the same cropping pattern as described in the paragraph (1).

Under those conditions, cropping system related to single culture of rice and vegetable culture in wet season is explained here.

Figure 4-5-1 Cultural systems recommended to irrigated perimeters



The rice variety to be recommended is Bouake 189 as in the case of gravity irrigation. Although the single cropping within a year permit a flexible choice of rice cropping period in wet season, it is desirable to carry out seeding at the beginning of July and harvest at the middle of November if considered the necessity to save the pumping expenses by effective utilization of rainfall. At any rate, pump operation should be controlled and managed carefully by the GVC(s) under the appropriate irrigation plan, because the pumping expenses occupy a considerable part in production cost, and further, unexpected trouble might sometimes cause a complete interruption of water distribution. Here also, the type of rice culture is based on direct seeding by broadcast.

Vegetable production always includes tomato and onion as main crops, but is shifted to wet season. To prevent the labor competition with rice culture, a recommendable way is to transplant tomato and onion at the middle of June and to harvest tomato from September to October and onion in October. The rotation system is similar to that in the gravity irrigation: 4 years rotation of Tomato - Onion - Okra - Immature Maize. Watering method by the use of watering can be also adopted here.

The land allotment ratio is similarly fixed as 80 % to rice and 20 % to vegetables with the same target yields. The installation of a rice mill in the union of GVC would raise farmers' benefit even in the case of single cropping of rice.

The proposed cropping pattern in pump irrigation is illustrated simultaneously in Fig. 4-5-1.

4-5-2 Agricultural Production involving Rain-fed Crops

Agricultural production involving rain-fed crops is quite variable, including permanent crops like coffee and cacao, food crops for subsistence like yam, cassava and maize, and cash crops like upland rice and cotton. In contrast to the newly introduced crops like irrigated rice and vegetables to be grown in the developed perimeters, those old crops are commonly grown in the traditional way inherited from the ancestral age. Therefore, to draw the production program involving rain-fed crops, special caution should be taken to respect the people's traditions and customs as much as possible on one hand, and to make efforts to eliminate the defects of old production system, aiming the gradual modernization and revision of it in long term, on the other.

The Master Plan of Agricultural Development 1992/2015 pointed out the extensive farming system of Ivorian farmers as one of the fundamental problems in agriculture of this country as follows:

"Agriculture of Ivorian farmers still belongs to the activities more or less of self-subsistence, if not collecting or picking, because it is quite extensive in many respects, characterized by the following points:

- Land-exhausting production system based on the shifting cultivation consists of slash -and-burn, associated cropping and long term fallow.
- Utilization of simple and multi-purpose tools which are only adapted to manual cropping systems.
- Since the farmers devote most part of their labor in food production to satisfy their domestic demand, some products are suffered from distortion between supply and demand on national level in certain periods of a year."

"In contrast to the growth of agricultural activities, forests in Côte d'Ivoire cover only 2.9 million Ha today, that is, 5 times less than in 1900."

"The pressure of population growth and the quick extension of plantation area, in particular of coffee and cacao, have strongly driven the people to clearance of virgin forests and to illegal occupation of classified forests."

As the similar situation is encountered commonly in the study area, it is of special importance to draw long-term perspectives on the development and modernization of agricultural production, taking the re-construction of natural ecosystems into account.

From this point of view, the end objects to be attained before 2015 in this Master Plan are decided as follows: firstly, to promote stepwise transformation of the shifting cultivation system with slash-and-burn to the rational and sustainable rotation system; secondly, to achieve the programmed renewal of over-aged plantations of coffee and cacao, and to create artificial grasslands, agro-forestry land and production forests in the actual wasteland like bushes and savannah and low-utilized land like fallow.

The middle-term targets will be stressed on two points: to improve crop production of people's basic foods like yam, cassava and maize on one hand, and to develop the cash crop production including coffee, rain-fed rice and cotton on the other.

To attain those aims, the propositions are given in 3 separate types of production; (1) the food crop production including yam, cassava and maize, (2) the annual cash crop production like rain-fed rice and cotton, and (3) the perennial cash crop production, that is, coffee and cacao.

(1) Food Crop Production

In common practice of shifting agriculture, the yam, people's basic food of this region, is usually grown in the first year after slash-and-burn because this crop requires fertile soils. In general, yam is planted traditionally in association with cassava, and other crops like banana, corn, some species of vegetables etc. often come into association. After harvesting yam in the first year and cassava in the second, farmers let the land in long-term fallow in most cases. Those facts clearly prove that the farmers give priority to yam culture to satisfy their own demand for basic food in the study area. It should be noted, on the other hand, that the priority of yam culture forces the farmers to adhere to shifting agriculture with slash-and-burn. To improve the practice of growing yam is a key technology to innovate the traditional shifting cultivation.

In agronomic point of view, the associated cropping of yam and cassava might raise problems related to the mutual competition in nutrients as well as the degradation of soil fertility because those crops both belong to the tuberous plants. However, the associated culture of yam and cassava cannot be eliminated immediately if considered the fact that the basic foods supply of farmer's family depends exclusively on this traditional and accustomed system. Taking those points into account, the following 4 years rotation, which includes associated culture of yam and cassava, is proposed as a basic food production system.

Yam , Cassava - Peanut - Maize

Yam requires fertile soils of high moisture holding capacity but well-drained, which is assured by high content of organic matter in the soil. One of the characters of this rotation is to restore soil organic matter by introducing the maize residues into the soil before planting yam and cassava, and to prevent the degradation of soil fertility by applying fertilizers to every crop. Peanut and maize are not only the important food crops for the people, but will play role to maintain soil fertility by the production of organic matter and the fixation of atmospheric nitrogen. When yam is grown in association with cassava, special attention should be paid for the planting density to minimize the competition between two crops in nutrients and light. The technological guidelines to grow crops in the rotation are given in the Annex (see Annex D-2).

At transitional stages, a short period of fallow might be inserted after maize. It is, however, recommended to grow grasses for grazing like Guinean grass or elephant grass, desirably associated with leguminous forages like Centrosoma or Stylosanthes to create the artificial grassland for animals. On the other hand, re-forestation of the farm after harvesting

cassava would be another way to be recommended, where the annual crops like peanut and maize can be grown in interstitial cropping during a few years of initial stage of tree growth. At any rate, it is expected that one or some combinations of those methods will stimulate farmers' intention towards the stepwise liberation from the destructive slash-and-burn practice, and towards the creation of artificial grassland and the re-construction of productive village forests.

Based on the discussions with the ANADER experts, target yields of the crops contained in this rotation were fixed at 15-20 t/ha for yam, 15-20 t/ha for cassava, 3 t/ha for peanut in pod and 3-3.5 t/ha for maize.

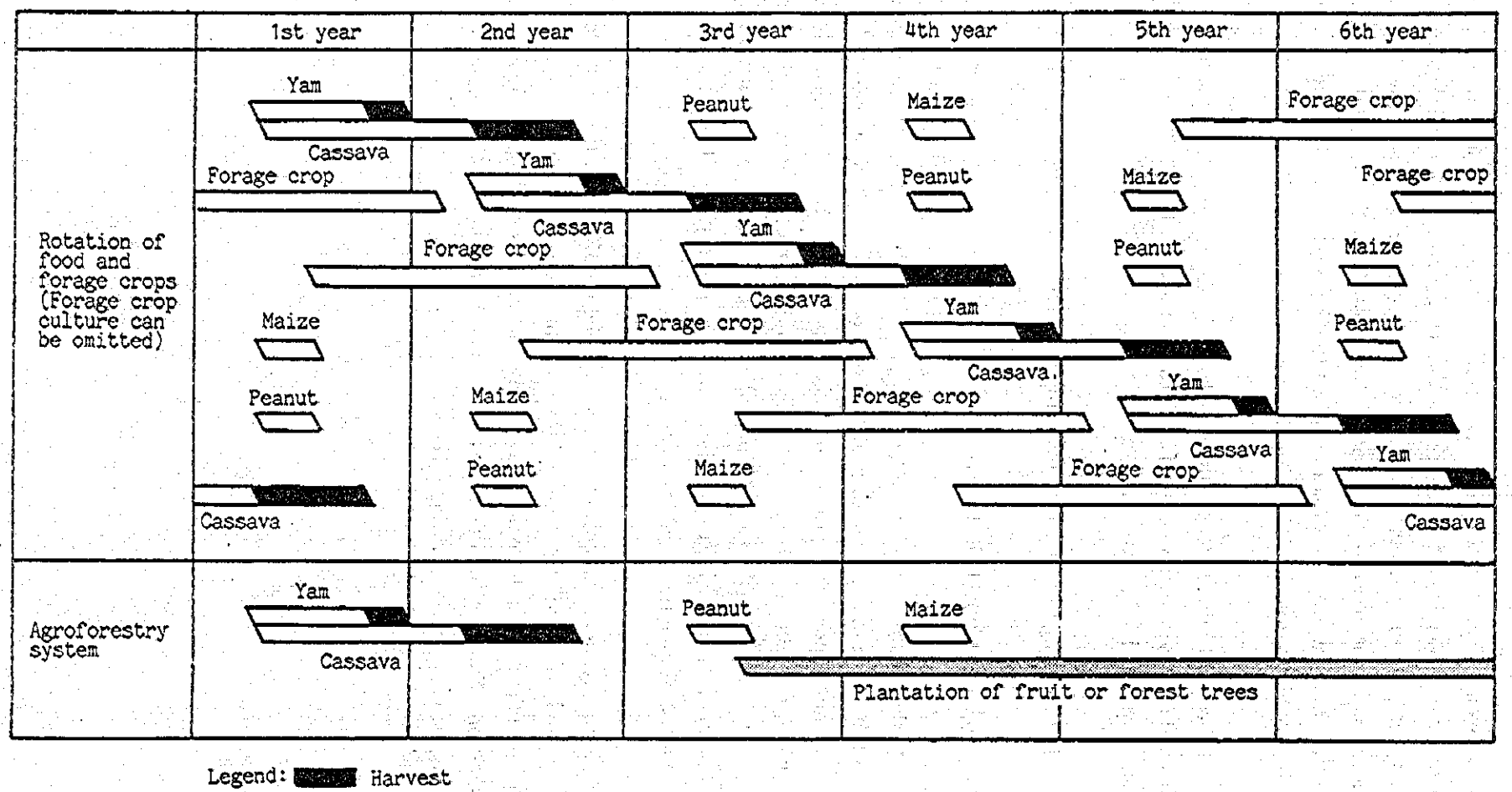
The cropping patterns of the food crop production are illustrated in Fig. 4-5-2.

(2) Annual Cash Crop Production

In the traditional system, upland rice is usually grown for a few years successively after slash-and-burn of the fallow land, then the cropped area is abandoned and let in fallow again. Common practice of growing upland rice is associated culture with maize, though the density of the latter is relatively low. The farmers' practice of short cropping duration appears to arise from the fact that upland rice is quite susceptible to harmful effects of continuous cropping which result in quick drop of the yield. Furthermore, continuous cropping of rain-fed rice should be avoided.

Similarly, in the current system, cotton is often grown in the first year after burning of fallow land, followed by peanut and maize culture for a few years. Thereafter, the farm enters in fallow again. In contrast to upland rice, cotton is never grown in association with other crops. Since upland rice and cotton can be easily integrated in rotation, it is urgent necessity to improve the growing practices.

Figure 4-5-2 Cultural systems of food crops



Proposed rotation is 4 years system as follows:

Upland rice - Cotton - Peanut - Maize.

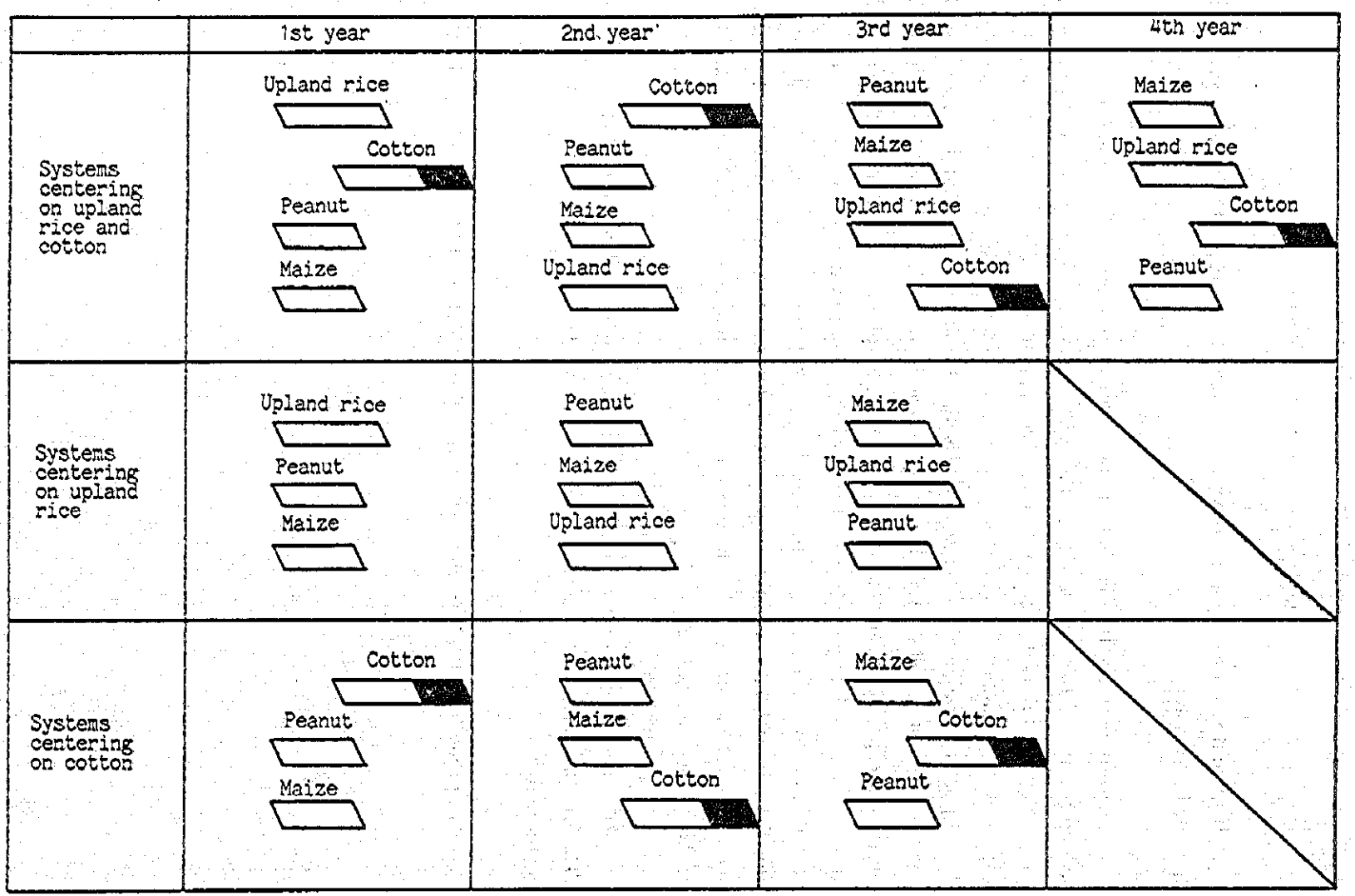
If upland rice or cotton is grown as a single main crop, the rotation cycle will be shortened to 3 years.

The proposed rotation is characterized by a combination of the intensive culture of cash crops, upland rice and cotton, and the restoring system of soil fertility by peanut and maize. As peanut is a nitrogen-fixing leguminous plant, and maize a productive cereal, both crops must play important role not only in food production but to prevent unfavorable effect of continuous cropping and degradation of soil. One can imagine that the rotation will be more intensive if introduced double cropping within a year by inserting another crop with short growth period, peanut or maize for example, preceding cotton culture. This idea, however, is not valid by the reason that it involves big risk due to unstable distribution of rainfall in the growing season of preceding crop. Proposition concerning with the land use after the elimination of fallow is the same as described in the paragraphs of food crop production. The technological guidelines to grow the two crops in the rotation is attached to the Annex (see Annex D-2).

The yield targets are fixed as follows by discussions with the ANADER experts: 2-2.5 T/Ha for upland rice, 1.5 t/ha for cotton with grains, 3-4 t/ha for peanut in pods and 3-3.5 t/ha for maize.

The cropping patterns of annual cash crop production are illustrated in Fig. 4-5-3.

Figure 4-5-3 Cultural systems of annual cash crops



(3) Perennial Cash Crop Production

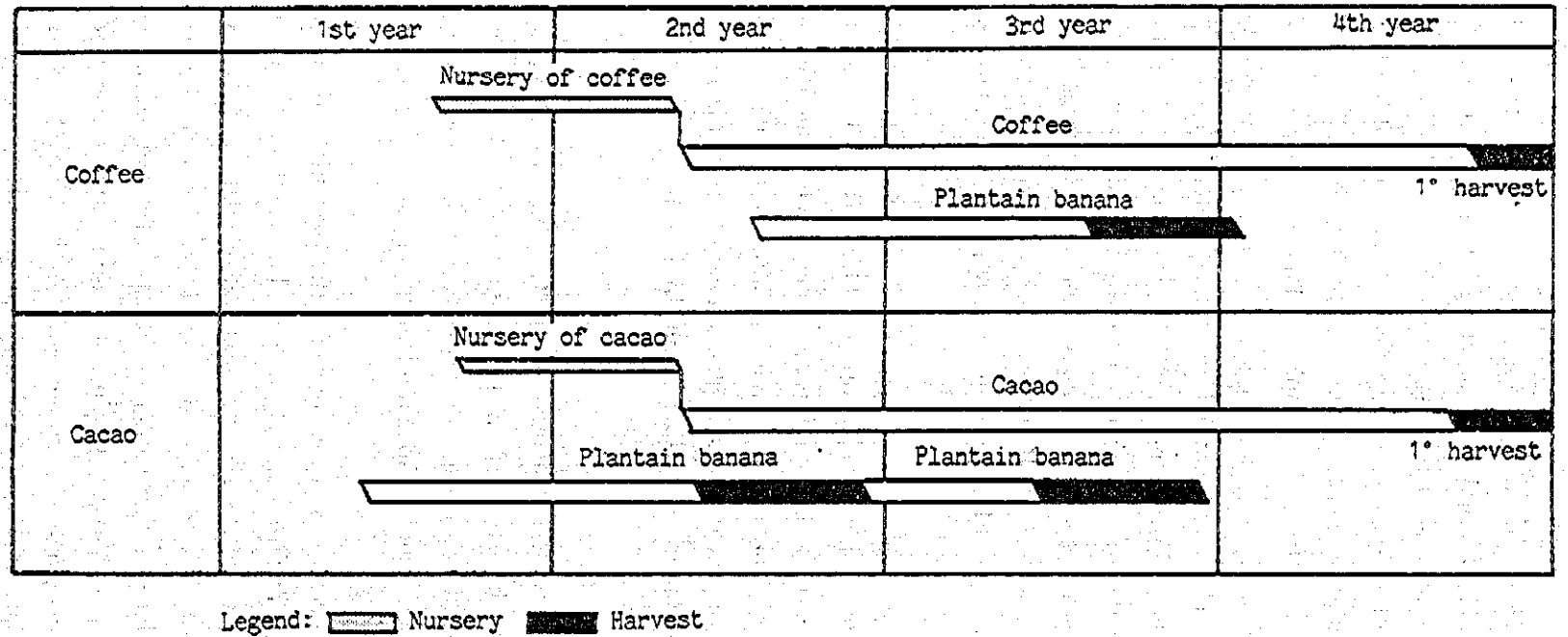
In spite of marked decline observed in recent years, the coffee and cacao plantations still occupy a vast area in the study area (about 32,500 ha of coffee and about 14,000 ha of cacao plantations in sum total of the 4 sub-prefectures concerned), and would remain as important cash crops of the region in future. On the other hand, it is difficult to overlook the future extension of coffee and cacao plantations in this region, because the Master Plan of Agricultural Development 1992/2015 emphasized the necessity of re-structuration of those two crops, particularly in cacao sector, proposing the reduction of cropping area to stabilize national production. However, the Master Plan pointed out as key measures in re-structuration policy the following two points; the rejuvenation of aged plantations on one hand, and the improvement of product quality by the introduction of more performant varieties on the other. Along this line, the programmed re-planting of all coffee and cacao plantations is recommended here. If achieved this program, the plantations of coffee and cacao in the study area would have normal and appropriate cycle of rejuvenation of 25 years.

Improved varieties of arabusta by coffee and hybrids by cacao are used in re-planting program. At the time of re-plantation, it is recommended to plant plantain banana as cover crop 1 year before re-planting of cacao or as interstitial crop in the same year for coffee re-plantations. It is because the demand of plantain banana is increasing and active in urban areas whereas the production would be diminishing in future as a result of reduction in cropping acreage of cacao.

Target mean yields after re-plantation are; 1.2 t/ha for coffee (as coffee beans), 1.5 t/ha for cacao (as cacao beans) and 4 t/ha for plantain banana. The technological guidelines for coffee, cacao and plantain banana are attached to the Annex (see Annex D-2). The cropping patterns of coffee and cacao at re-planting stages are shown in Fig. 4-5-4.

When a grower decides the re-planting of coffee plantations, the operation requires not only big finance to get seedlings and plastic pots, but plenty manpower to clear and clean old plantations, then to conduct soil preparation, transplantation and necessary maintenance. Moreover, the grower has to wait for 3 or 4 years before the harvest starts. The circumstance is similar or rather harder in the case of cacao because it necessitates the preparatory procedure to plant cover crops, plantain banana, 1 year before planting cacao seedlings. Since the delay in rejuvenation program of the ANADER is principally attributed to the insufficient supply of finance on both farmer and ANADER sides, special measures

Figure 4-5-4 Cropping plan by the renewal of coffee and cacao plantaions



should be taken in this respect, for example, by restoration of credit system. Further, the institutional organization seems to face critical conditions. Actually, 2 coffee nurseries of the SATMACI in the Department of Dimbokro has been closed in 1992 due to budget shortage. Countermeasures in finance are expected to cover such technological constraints. Fortunately, the Ivorian Government has started a policy of "La Relance cafeiere" in September 1994 to offer financial aids to the growers and growers' groups who are planning the rejuvenation of aged coffee plantations more than 5 Ha. It is expected that this policy will stimulate and promote the re-planting of degraded plantations in the study area. On the other hand, the Government of Côte d'Ivoire, based on the policy of quality improvement, has decided to fix the guaranteed price only for coffee beans, and not for non-threshed coffee from the year of 1993/94. Because the small growers has hitherto sold their products in non-threshed ones, many coffee-growing villages having no coffee-threshers face to new-born difficulties, and obliged to sell their products to buyers of private sector by unreasonably lower prices. The problem of coffee-thresher can not be neglected in this sense, some financial countermeasures will be necessary to encourage coffee growers.

4-5-3 Integration of Irrigated Perimeters and Rain-fed Lands

The present Master Plan includes the irrigation development of about 4,600 ha, of which most part will be devoted to paddy rice culture, but some minor part is not adequate to growing rice because of high water permeability of soil. On the latter part, the best way of land utilization will be to grow cash crops like vegetables and cotton, or food crops like yam, plantain banana, maize etc. under occasional supplementary irrigation, or under small-size irrigation for more profitable off-season production.

It was stated before that the introduction of agricultural machines is one of the essential factors to realize double cropping of rice in the irrigated perimeters. If time allocation of mechanical works is possible, those machines can be efficiently utilized both on irrigated perimeter and rain-fed land. Thus, it is expected that the introduction of machines would play an important role in improvement of rain-fed agriculture also. Finally, by-products of irrigated perimeters like rice straw, rice bran or vegetable residues would stimulate the introduction and development of cattle breeding in the neighboring villages by furnishing basic fodder in dry season. Animal husbandry thus settled must have increasing demand of fodder, which gives rise to the creation of artificial grasslands. Such an impact is expected to accelerate the traditional shifting agriculture to the rational rotation system.

On the other hand, in the irrigated perimeters, it is presumed that the agricultural activities on rain-fed land might concentrated on yam, cassava and maize, that is, food crops for domestic consumption, because most part of family labor would be devoted to double

cropping of rice and vegetable production, and rain-fed rice production would be canceled due to very lower yield than irrigated rice. Therefore, the future perspectives on coffee and cacao production as well as other types of rain-fed culture should be carefully examined from the standpoint of not only concerned villages but also the regional development policy of the concerned Departments.

The preliminary estimation of the production costs and expected gross benefits of every crop included in the production program of the Master Plan are given in the Annex (see Annex D-3).

4-5-4 Animal Production Program in relation to Irrigation Development

(1) Animal Husbandry

The Master Plan of Agricultural Development 1992/2015, on the background of increasing import of meat and milk products in recent years, emphasizes the combination of agriculture and animal husbandry as one of the most important objectives of the policy, laying special attention on breeding of traction cattle to improve the agriculture depending solely on man-power.

As described in the present situation of study area of the Chapter 3, animal husbandry in this region still remains in quite primitive state. Among the causes for it, fodder deficit during dry season and insufficient number of drinking points occupy important place. Rice straw, a by-product of irrigated rice culture, will be conveniently served to the animals as basic fodder in dry season, and water-drinking points for animals can be easily equipped in the perimeters after the construction of water reservoir. Consequently, animal husbandry, particularly cattle breeding, could be developed in the villages concerned with project. Although the idea to utilize cattle as traction animal for farm works is attractive, it would be better to promote this program in a long-term perspective because the patient efforts for training of farmers as well as animals would be required. In this sense, successful experiences in the Northern Region will serve as an example.

(2) Fish Culture

Some attempts of fish culture has just started in the study area, but the accumulation of experiences is still poor. On the other hand, it appears that demand of the population for fish is increasing. So, the construction of ponds for fish culture is recommendable to irrigated perimeters in the project. In this case, it is desirable to carry out previously a detailed study on the markets and transporting means.

4-6 Agricultural Supporting Plan

(1) Necessity for Supporting System

In terms of food crop sector, paddy cultivation and vegetable cultivation in particular, the former C.I.D.V. had been the responsible agency for the promotion of agricultural technology, farmers' organization, coordination, project management etc., until the new extension agency called A.N.A.D.E.R. was established in September 1993. A.N.A D.E.R. was created by merging ex-C.I.D.V., ex-S.A.T.M.A.C.I. and ex-S.O.D.E.P.R.A. As a result of this unification of these extension functions, it became possible to provide more comprehensive extension services to the farmers.

The agricultural operation program adopted in this plan will mainly emphasize the irrigated cultivation of rice with some considerations to the production of vegetables and farm crops. Since the villagers in the surveyed areas have little experience of irrigated agriculture, various problems are anticipated during the introduction of the planned cultivation. The possible problems upon applying the Plan and some suggestions to solve these problems are suggested below.

(a) The farmers are inexperienced with the management and operation of the irrigation water. Therefore, the support and organization will be required.

(b) The farmers do not have enough required cultivation skills. They will need to learn the modern agricultural techniques in replacement of their traditional ones.

(c) As considerable amount of production fund is necessary, the farmers will need to collect a certain amount of capital.

(d) Most importantly, the leaders will need to be trained to carry on proper management and maintenance of the improved development areas. In addition, the farmers will need to learn the skills required for the maintenance and operation.

(2) Supporting Organizations

As mentioned above, the farmers in this area will encounter certain problems during the development of the new agricultural system. Therefore, a consistent supporting system ranging from the formation of the organization to the management is indispensable. Therefore, ANADER should be responsible for the extension system in this project. In other

words, ANADER should take initiatives in controlling the support from all the associated departments and act as the coordinator for the farmer groups.

The items required for the support are as follows:

(a) Establishment of the farmer organizations
(b) Support for the agricultural operation skills
(c) Management of water
(d) Management of the lease and maintenance of machinery
(e) Marketing activities
(f) Management of organizations, business and others
(g) Financing of fund

(3) Supporting Unit for Extension

The supporting unit for extension service aims to give the comprehensive extension services to farmers under the corporation between the experts of A.N.A.D.E.R. and the other government concerned officers. The supporting unit for extension service will be formed as follows.

Table 4-6-1 Supporting unit for extension

Organization	Specialty
ANADER	Crop production specialist Irrigation specialist Organization specialist
OCPV	Marketing specialist for food crops
M.F.P.F	Rural animator
Total	5 specialists

Note: The crop production specialist will deal with matters of livestock and forestry.

(4) Agricultural Financing

To implement modern agriculture, not only technological support but also the fund for agricultural operation fund need to be secured and provided. However, since termination of the BNDA operations, the farmers in effect have had no ways to receive any systematic agricultural financing. Even though credit granting is essential for the success of the

agricultural operations, there is no means for any systematic financing. This situation needs to be overcome with such solution as the credit sales of the farm input by the agricultural cooperative associations. Furthermore, it will be difficult, at least at the initial stage, to implement a type of financing based on mutual aid among the farmers of the project. Nevertheless it is recommended that the gradual transition to this type of financing be accomplished during the project period in addition to the progress of economical accumulation and technological acquisition. The irrigated agriculture in this plan will require the following two types of credit granting.

- Credit for farm input-short term-(seed, fertilizer, chemical, fuel)
- Credit for farm machinery-medium term-(walking tractors, rice milling, etc.)

(a) Credit for Farm Input

In crop production sector, short term credits play an important role. Through short term loan, farmers can ensure procurement of improved seeds, fertilizers, and other chemicals. The management of this short-term credit will be carried on by the farmers organizations, GVC, (supervised by the project office). This type of loan will be distributed to individual farmers through the G.V.C. or the Union. The short term loan will be distributed at the beginning of the planting period by in kind, and repaid after the harvest.

(b) Credit for Farm Machinery

This type of loan will be available to G.V.Cs and G.V.C unions under the management of the project office. The loan will be distributed in kind at the beginning of the project. G.V.Cs should collect depreciation cost from farmers each year to prepare for the renewal of machinery. The repayment will be made at the renewal time.
Since the mechanized farming and high input cultivation methods are proposed in the Master Plan, the demand for credit is likely to increase. Therefore, it becomes necessary for the project office to administrate management of financial loans and credits.

(c) The Establishment of the Project Fund

At present, it is impossible to seek for the capital for the agricultural financing from the systematic financing or the private banks in Côte d'Ivoire. Therefore the Project Fund must be established through incorporating the domestic and foreign capital to meet the short-term and medium-term credit demand. The purpose of the Project Fund is to assist the farmer organizations and farmers so that they can provide and manage the fund with

their own capital. Therefore, the farmer organizations and farmers need to borrow the operational capital from the Fund. They need to reimburse a proportional amount from the profit and while accumulating the fund reserve among themselves. For this purpose, the Fund should be managed and operated by the Project Office and expert managers of funds in a proper and expert way.

i) Short-Term Credit

The basic provisions of the short-term credit are as follows:

- The farmers will sell their product through the GVC and the GVC union.
- The GVC will borrow the capital from the Project Fund to purchase the necessary farm input, and provide it to the farmers.
- After harvesting, the farmers will pay the amount corresponding to the loan repayment and interest to the GVC out of their sales income, then the GVC will reimburse to the Project Fund on behalf of the farmers.
- When the farmers make the loan repayment to the GVC, the paid amount will be deducted from the sales income of the joint sales.
- The GVC and the farmers will work towards the establishment of independent agricultural operation within about five years.
- For the above purpose, the farmers, while making the loan repayment of the operational capital, will reserve part of the profit to establish their own fund by the fifth year.
- In this case, the reserved amount per year will be approximately one-fifth of the operational capital loan.
- Therefore, the GVC will utilize the external capital for about five years as the operational capital. From the sixth year, the fund will be managed by the internal capital.

In this Master Plan, the development of the N'Zi River mainstream and the tributary streams will create the planted area of 5,300 ha for the paddy rice and 1,300 ha for vegetables, both including double cropping. To develop the irrigated agriculture in this development area, the total credit of approximately two billion CFA F per year would be required for the purchase of the farm input for all the areas (see Table E-2-8). After the sixth year when the economic accumulation is expected to rise to a degree, it is preferred that the farmer organizations and the farmers continue to support the agricultural operation fund using the accumulation of their own internal capital.

ii) Medium-Term Credit

The basic provisions of the medium-term credit are as follows:

- The farmers will sell their product through the GVC and the GVC union.
- The GVC or the GVC union will purchase the necessary agricultural machinery using the Project Fund. The union will manage the agricultural machinery and provide the lease service of the machinery to the farmers on its own initiative.
- The farmers will pay to the GVC or the GVC union a certain amount of charge for the machinery lease service.
- The GVC or the GVC union will collect the lease charge and reimburse the loan and the interests to the Project Fund. Preferably, the reimbursement period will be the same as the depreciation period of the machines.
- The GVC or the GVC union, while reimbursing the loan, will accumulate the fund for the replacement of the machinery. The cost of the machine replacement will be collected in the form of the lease charge.

The paddy rice cultivation plan in areas where the Master Plan is applied expects the production of approximately 32,000t of rice per year. If the 80% of the produced paddy is milled by the farmers themselves, approximately twenty rice mills with the performance of 0.5t/h would become necessary. Additionally, one tilling machine would be needed in every 10 ha, which results in the total of 400 machines for all the areas concerned. Similarly, one grain threshing machine would be necessary for every 20 ha, amounting to the total of 200 machines in concerned areas. From the numbers above, the purchase cost of 1,500 million CFA would be required as the amount of loan needed for the agricultural operation machinery.

(5) Training

The farmers implementing a new type of agricultural operation will need to have training on the administration of the organizations appropriate for the irrigated agriculture, on the management of the irrigation facilities and on the handling of the agricultural machinery.

(a) Training on the Management and Administration of the GVC Organizations

The staff in charge of organizing ANADER from the Project Office and the supporting unit for extension will prepare the GVC administration manual in advance. This manual will be used as a guideline for the on-the-job training of the GVC staff on the administrative management, including the clerical works.

(b) Training on the Daily Management of the Irrigation Facilities

As in (a), the ANADER staff and others will provide on-the-job training based on the manual on the irrigation facilities management, on the operation and management of the dam facilities, irrigation and drainage canals.

(c) Training on the Operation and Maintenance of the Agricultural Machinery

Because the Grand-Lahou Agricultural Machinery Training Center operated by ANADER will provide training on the agricultural machinery (including the courses on tractors, tillers, rice mills, grain threshers and reapers), selected trainees will be delegated to learn the skills required to operate and repair the machinery.
In the Master Plan development areas as a whole, it is expected that approximately 160 trainees and 17 million CFA F training expense will be needed for the training programs for the tillers, grain threshers and rice mills planned to be introduced (See Table E-2-14).

4-7 Plan of the Farmer Organization Development

(1) Necessity of the Farmer Organizations

As described in the Agricultural Development Master Plan, in order to accomplish the economic development of the farmers, the economic independence through the reinforcement of the farmer organizations should be achieved. In the surveyed areas, GVC's have been established to promote the production of various crops. However, these GVC's mainly promoting such export crops as coffee and cacao cannot adapt to the changes in the economic and natural environments, resulting in the sluggish activities in many cases. It is true that new GVC's mainly dealing with paddy and vegetables are beginning to be formed in some areas, but, as this plan emphasizes the irrigated paddy cultivation incorporating other vegetables cultivation, the farmer organizations which can deal with such operations need to be formed. The establishment of new GVC'c as well as the reinforcement of existing GVC's and the introduction of new crops will be required, and it is important to reinforce the organization uniting these GVC's, with the prefectural federation of the agricultural cooperative associations as its center.

(2) Different Level Organization

It will be required for the farmers' organizations to establish the following different levels of groups.

(a) Groups for Farm Management consisting of a Maximum of 10 Farmers at Field Level;

The farmers who group themselves by affinity, will cultivate together and take irrigation water in their parcels etc.

(b) Groups for Production and Marketing Management at Village Level;

This group will be a G.V.C based on a village, which will be in charge of the input supply, the management of account, credit and marketing etc.

(c) Groups consisting of Various Villages /G.V.Cs.

This group will be the same as a cooperative and this type of group should focus on economical activities such as marketing section and agro-processing section etc.

(3) G.V.C's Functions

A G.V.C will be established at village level , which will involve four (4) committees, i.e. (a) management committee for farm inputs, (b) management committee for operation and maintenance, (c) management committee for machinery, (d) management committee for marketing , headed by a president of the G.V.C.

The role of the four(4) committees headed by a leader each , is summarized as follows.

(a) Management Committee for Farm Inputs,

This committee manages agricultural inputs necessary for their farming. The one leader checks the amount of inputs and the total cost and arranges to distribute inputs to farmers.

(b) Management Committee for Operation and Maintenance

In the study area, rain-fed agriculture is dominant and there is no existing irrigation system excluding M'Bahiakro perimeter. Therefore, it is necessary to establish a development management committee responsible for water management and maintenance of facilities including canals. In addition, the water charge (les redevances d'exploitation) will be collected by this committee.

(c) Management Committee for Machinery

This committee is responsible for management of introduced machinery and making of a schedule of machinery operation.

(d) Commercialization Committee

This committee is responsible for all marketing activities. It collects marketing information in order to sell their products at a good price.

In addition to the above mentioned four(4) committees, two specialists, a repairer (mechanic) and an accountant will be needed for a good handling of financial matters and maintenance of machinery.

(4) Production Unit on the field

A production unit is a group of farmers by affinity who work together in a field(block) consisting of several fields(parcels) based on an irrigation block. A production unit runs water into their parcels, and conducts maintenance of secondary canals and drains.

(5) Development of Farmer's Organization

(a) Establishment and Reorganization of G.V.C

In the Master Plan, more than 20 perimeters will be developed for irrigated paddy cultivation and vegetable. The farmers in these areas have no experience in irrigation farming. Therefore, each perimeter should establish a new G.V.C. or reorganize an existing G.V.C. for coffee and cacao.

(b) Creation and Reorganization of G.V.C. Unions and Cooperatives

As mentioned in "Master Plan of Agricultural Development 1992-2015", the government emphasizes to promote the creation of G.V.C unions . In the proposed development area, a Cooperative ENTENTE exists at Dimbokro town and a G.V.C. union at Bongouanou town. The proposed strategy is as follows.

i) Dimbokro Department

The cooperative ENTENTE of Dimbokro has engaged in marketing activities for not only coffee and cacao but also paddy and rice. In parallel with agricultural

development, the cooperative ENTENTE should be strengthened concerning both human resources and equipment.

ii) M'Bahiakro Department

In the M'Bahiakro department, there is no GVC union. It is proposed that the existing farmer's groups in the perimeter should be organized under a central office of G.V.Cs and get involved with G.V.Cs of proposed development areas.

iii) Bongouanou Department

A G.V.C union dealing with the marketing of coffee and cacao exists in Bougouanou town. However regarding the marketing of rice this union will face a serious competition with private companies such as SORIZCI, which is gradually developing its activities of collecting, milling and marketing of rice. Therefore, it is proposed the re-establishment of the G.V.C union of M'Batto sub-prefecture, which stopped its activities since 1992, instead of reorganizing the G.V.C union of Bongouanou.

4-8 Marketing and Agro-Processing Plan

(1) The Necessity of Marketing by the Farmers

Marketing by the farmers themselves will aim at their economical profits through their improved selling abilities, the suppression of middleman and the optimum marketing period. In addition, the post-harvest handling of the agricultural products will reduce the losses after harvesting and enable the value-added sales. These measures will not only profit the farmers, but also facilitate the agricultural product marketing and invigorate the communities.

In the applicable areas, not many cases of farmers participating in the marketing activities are seen, except for the export crops such as coffee and cacao. In any case, the GVC's and the prefectural union of the agricultural cooperative associations should assume the main responsibility for the marketing activities in these areas. The marketing activities and the post-harvest handling centering around the agricultural cooperative associations will enable the development of the advantageous sales by the farmers.

The marketing and agro-processing plan can only be achieved through the reinforcement of the farmer organizations and, therefore, must be consistent with the farmer organization plan. The marketing and agro-processing plan includes the following.

(2) The Promotion of Marketing Activities through the Reinforcement of Agricultural Cooperative Associations

The organizations presently managing the sales of the agricultural products are the prefectural union of the agricultural cooperative associations and the civic agricultural cooperative associations, operated by female workers. This plan consists of the positive promotion of the marketing activities consistently managed throughout the crop collection, processing and sales, utilizing these agricultural cooperative associations.

The reinforcement of the prefecture-level agricultural cooperative associations

(a) the establishment of the operations such as rice milling and coffee processing
(b) the installation of the storage facilities
(c) the procurement of transportation means (trucks, etc.) for the purpose of improving crop collection abilities
(d) the reinforcement of the market information collecting system

The reinforcement of the GVC (village-level)
(a) the establishment of the marketing organizations, with several villages (GVC's) as a unit
(b) the installation of small-sized rice mills
(c) the installation of village storage houses

(3) The Introduction of Small-Scale Agro-Processing

(a) the village-level operation of peanut oil expression by the female workers
(b) the processing of cassavas

(4) The Establishment of the Guidance System

(a) the implementation of marketing operation training for the members of the agricultural cooperative associations and GVC's
(b) the supply of information on the cultivation environment and the market

(5) The Role of the GVC's

The purposes of this marketing and agro-processing plan are, through the operation consistently managed by the GVC's throughout the crop collection, processing and sales as described above, to reduce or suppress the part played by the middleman in the past and to

implement advantageous marketing activities for the farmers. In this regard, the GVC's and the union will play a very important part.

The marketing committee of the GVC's, through conferences with the OCPV staff and the marketing committee members of the union, will obtain the marketing information and have it reflected in the cultivation plan and cultivation period. In the crop collection period, the union will accomplish advantageous sales by arranging trucks and gathering information on the market prices.

(6) The Sales and Marketability of the Products

In this Master Plan, the paddy rice and vegetables produced in the irrigated agriculture are the main crops. From the viewpoint of promoting the marketing by the farmers themselves, all the amount of the product, excluding the portion for self-consumption and seeds, will be basically provided for the joint sales through the GVC's and the GVC union in principle. Especially as to the rice, as it will be sold with added value by milling it by the GVC's and the GVC union, the possibility of making it obligatory for the farmers to deliver the whole amount produced is a point that needs to be considered. The vegetables, on the basic premise, will be delivered to the neighboring wholesale market (in the city of Kotobi).

Placing in the GVC union the marketing specialists and placing in the extension support unit the staff of the OCPV which supports the marketing of food crops under the control of the Ministry of Commerce will enable the smooth communication of the marketing information and accomplish the timely sales.

The marketability of the rice and vegetables is as described below.

(a) Rice

Côte d'Ivoire, at present, has the self-sufficiency of rice ranging from approx. 40 to 60% and rely on import for approx. 300,000t per year. It is an urgent matter to increase the domestic production and improve the self-sufficiency. Furthermore, as the staple food in the applicable areas are yam and cassava, rice as a secondary food will be a promising cash crop for the domestic market.

As shown in Figure 4-8-1, the GVC's and the GVC union will play the most important role in the marketing channel of rice. The rice produced in the planned areas will, in principle, be provided for the joint shipment through the GVC's to the union. The union

will secure the rice mills and transportation means and assume the role of the collecting and processing agents in the past, thereby realizing the profit return to the farmers.

(b) Tomatoes

Around 25,000t of tomatoes are imported every year from European and neighboring countries, showing a great demand in the domestic market. Furthermore, the wholesale market of food crops including vegetables is established in the city of Kotobi in Bongouanou prefecture, securing a stable market.

The produced tomatoes will be sold primarily in the Kotobi wholesale market through the joint shipment, taking advantage of the market information.

(c) Onions

As in the case of tomatoes, more than 20,000t of onions are imported every year from the neighboring countries such as Mali and Burkina Faso, showing a great domestic demand, and there is a stable market like tomatoes.
The market and means of sales will be the same as tomatoes.

(d) Other Vegetables

As other vegetables are produced in a small scale, they will be sold in the local market for the household income. The primary marketing channel for all the vegetables will be the sales in the Kotobi market as shown in Figure 4-8-2.

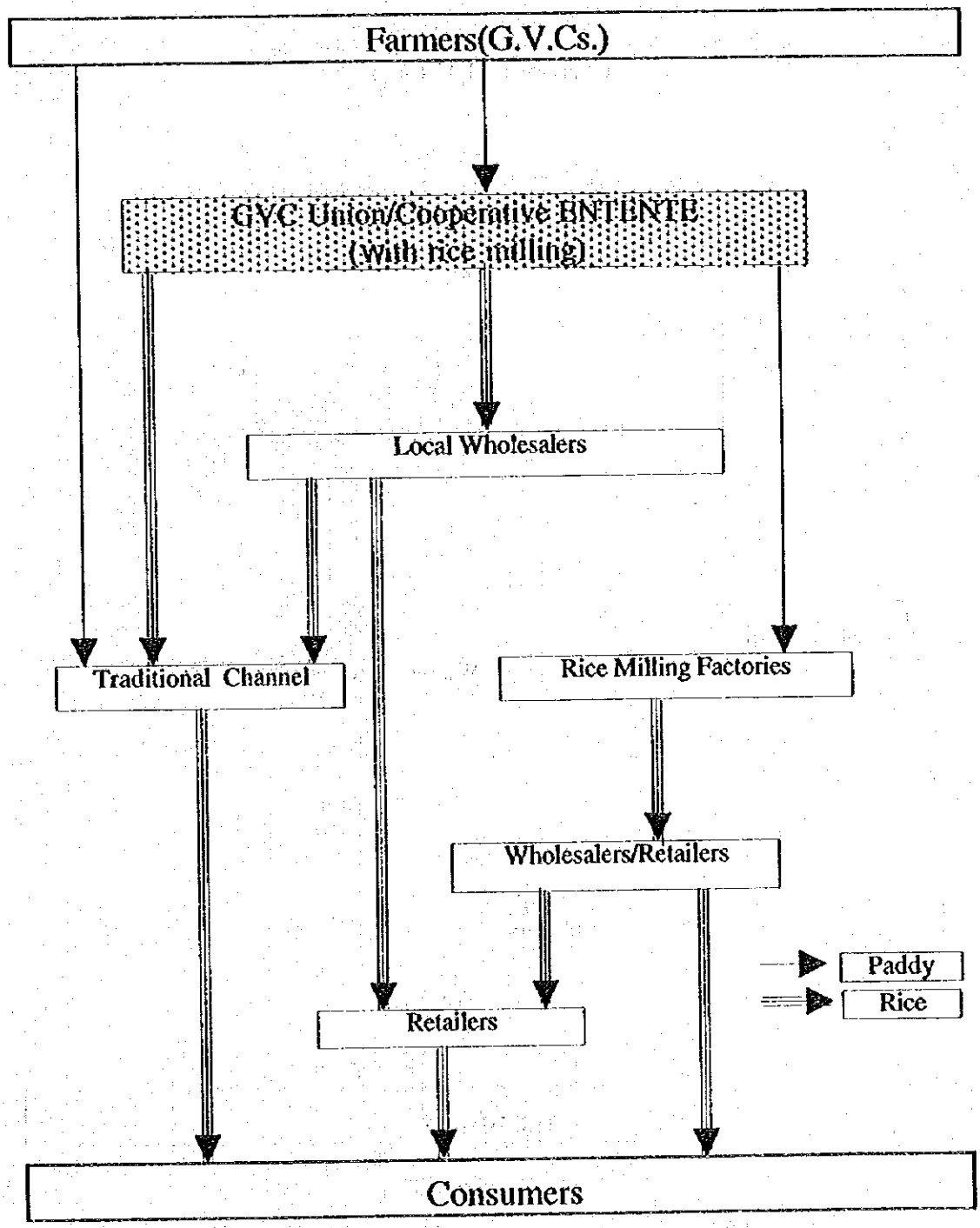


Figure 4-8-1 Marketing Channel of Paddy/Rice for the Study Area(Plan)

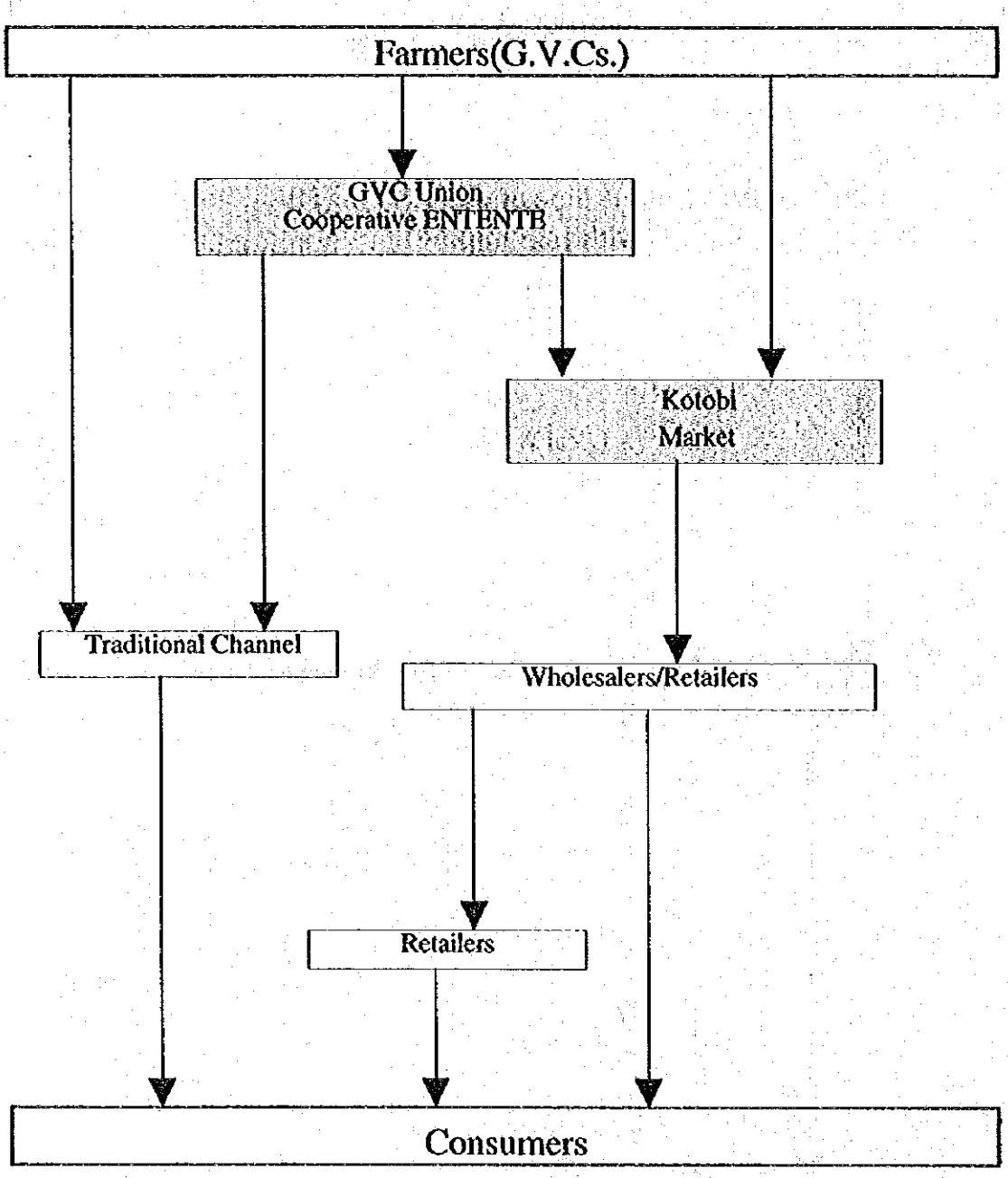


Figure 4-8-2 Marketing Channel of Vegetables for the Study Area(Plan)

4-9 Irrigation Structure Plan

(1) Dams on Tributaries of the N'Zi River

Earth dams for which most of embankment materials can easily be taken in the adjacent parts of the dam sites and moreover for which the hauling distance of the embankment materials is shorter will be constructed. The design flood discharge is to be 20 % up value of 100 year return period flood discharge. The storage volume of the reservoirs is decided by making water balance analysis taking into consideration the relations regarding inflow, water use, loss, sedimentation and the topographic & social conditions. The dead water volume is decided by estimating the specific sedimentation volume as results of the field sampling test at rivers running through the development priority areas. The estimated specific sedimentation volume is as follows;

Specific Sedimentation Volume : 40 $m^3/km^2/year$

As results of the above, the storage volume of the reservoirs are decided to be filled up every some 3 years in accordance with the proposed use of irrigation water

(2) Low Dam on the N'Zi River Main Course

The runoff ratio on the N'Zi river main course for 6 months from December to May is estimated at 4 - 5 % of the annual total runoff discharge, therefore the natural flow of the river for the irrigation use for this period is almost unavailable. Accordingly the construction plan of low dams to store flow for the period of rainy season in the minor bed of the N'Zi river main course in order to irrigate paddy field as much as possible for the period of dry season is conceived as mentioned in the option - 2. As the average riverbed gradient of the N'Zi is 1/6,500 and also the depth of the minor bed is 6 - 7 m, low dams of 5 m height shall be constructed. As for the dam type, as results of the comparison study between concrete dam with steel made flap gate and crest-up type inflatable rubber dam in terms of inflatability, construction & running cost and ease of operation & maintenance, etc., inflatable rubber dam is employed taking into consideration high reliability of inflation when big flood and less construction & running cost.

(3) Pumping Station

Despite any option on the irrigation development for the cropland along the N'Zi main course, pumping stations are required to divert water from the river. The irrigation command area by one pumping station is to be some 250 ha or less taking into consideration

the topographic condition and the efficient water management. The water level fluctuation of the N'Zi river is so big as 6 - 7 m throughout the year that a sluice way crossing the dike to introduce river water into a caisson type suction sump is laid and the water is lifted up by submerged motor pumps.

(4) Irrigation Canal

The irrigation canal network for the development areas is composed of headraces, main canals (or distribution canals), secondary canals (if development areas having 100 ha or more) and field canals. Concrete lining works are performed as for both headraces and main canals (or distribution canals) to prevent conveyance loss caused by water leak and slope erosion. The other canals are to be trapezoidal earth canal. As for along the headraces and main canals (or distribution canals), inspection roads having 5 m of total width which allows two vehicles to pass each other are planned.

(5) Field Lot Size

The cropland is broadly divided in paddy field and upland, of which land use plan is set up as 80 % of paddy field out of total irrigation area and the other 20 % of upland. Taking into consideration introduction of hand farming tractors, the standard field lot sizes are planned to be as follows;

(a) Irrigation area along tributaries of the N'Zi river 100 m x 20 m = 20 a
(b) Irrigation area along the N'Zi river main course 100 m x 30 m = 30 a

The on-farm development plan includes construction of field canals, field drains, on-farm roads, levees and related structures. For irrigated upland fields, paddy fields could be of multi purpose use, and the beneficiary farmers themselves would divide them in smaller lots if needed .

4-10 Environmental Conservation

(1) Conservation of Important Forests and Forest Lands

Although there are no national parks, nature reserves and plant reserves, 27 classified forests are assigned in and surrounding the study area. They are very important for environmental conservation, afforestation and water resources cultivation.

Technical approach for environmental conservation

- To conserve the classified forests in land use plan, and to prevent their exploitation.

(2) Protection of Important and Indigenous Fauna and Flora

Wild population of Hippopotamus, law protected fauna in Côte d'Ivoire, is found in the crescent shaped wetland of old stream of N'Zi river. They move upwards and downwards of the river, depending upon the natural condition in the dry season. The ecology of Hippopotamus is not fully known. Likewise, there is scanty knowledge of important flora in the primary tributary area.

Technical approach for environmental conservation

- Identification of the species of Hippopotamus , and further study on their behavior ecology in dry season.
- Elaboration of plan to protect Hippopotamus by concerned government officers. The plan will be to catch and relocate the animals to neighboring national park, or construct some appropriate facility at the dam site.
- Inventory of the important indigenous flora existing in the dams area.
- Elaboration of plan to protect the flora by concerned government officers. The plan will be to search for neighboring habitats, to replant the species in these habitats and to protect the habitats.

(3) Deterioration and Reforestation of Vegetation

Deterioration of vegetation will take place mainly at dam, weir, and channel construction, and dam material mining. Without reforestation, soil erosion will easily occur.

Technical approach for environmental conservation

- To minimize vegetation degeneration.
- To reforest borrow sites with trees and covering grass to protect the soil from erosion and runoff.

(4) Increased Use of Agrochemicals and Water Quality Deterioration

Irrigation project induces positive impact to yield increase and income increase of farmers. However the increased use of agrochemicals will induce negative impact to

environment, especially to water quality of river. Suitable application of fertilizer will be needed to maintain soil fertility.

Technical approach for environmental conservation

- Not to use the agrochemicals that will inflict damage to fresh water fishes.
- Ecological control of crop diseases and pests.
- To adopt suitable cropping system, such as crop rotation and inter cropping.
- To use high yielding, disease and pest resistant varieties
- To apply suitable fertilizer, especially organic fertilizer.

(5) Maintenance of Surface Water Quantity of Main Stream

The surface water of the N'Zi river is used for the drinking of the populations, the growth of fishes and Hippopotamus and the need of industries located down stream. Therefore, it is important to maintain minimum quantity of the surface water.

Technical approach for environmental conservation

- Maintenance of minimum quality of surface water of N'Zi river, especially in dry season.

4-11 Project Cost

Investment costs to study priorities of possible options for irrigation development were roughly estimated based on prices for unit quantities of tributary dams (embankment volume), low dams in N'Zi main stream, pump stations and on-farm works (developed acreage), which were obtained from costs estimated through the Feasibility Study for the same kinds of works of the development priority area. Investment costs for the Master Plan were compiled from those of selected development sites among all the above-mentioned possible options. Investment costs for rural roads, village water supply, post-harvest facilities and agricultural machinery and operation and maintenance cost were also estimated through the same way as in case of the irrigation facilities development.

Investment costs — Million CFA F

Items	Costs: Non Taxed Amount	Costs: Total
Irrigation and drainage facilities		
- 17 tributary dam sites	48,679	60,809
-2 N'Zi main stream pump-irrigated sites	12,281	15,351
Sub-total	60,960	76,160
Storehouses & milling equipment	647	872
Agricultural machinery	994	1,381
Rural roads 47.9 km	1,053	1,316
Village water supply 44 drilled wells	300	375
Detailed design & supervision 10% of construction costs	6,296	7,870
Project administration & supporting services	507	507
Fund for farming credit (production expenditure)	1,200	1,200
(machinery & equipment)	(1,362)	(1,362)
Total	71,957	89,681
Contingency (10 % of the total investment cost)	7,195	8,968
Grand-total	79,152	98,649

Remark: Machinery & equipment fund for farming credit is included in items of milling equipment & agricultural machinery.

Recurrence expenditure (annual costs) — 1000 CFA F

Operation & maintenance costs for irrigation facilities	
-M'Bahiakro pump-irrigated district 432 ha	22,500
-Bocanda pump-irrigated district 500 ha	26,000
-Tributary dam districts 3,615 ha	27,400
Sub-total	75,900
Associations of cooperatives	50,900
Extension services (for 10 years since the start)	113,500

4-12 Project Implementation Plan

4-12-1 Organization for the Project Implementation

Both the scale and the implementation period of the project planned in the Master Plan are respectively as 4 or 5 times large as those of the project planned for the development priority area. Therefore, the project implementation phase is almost the same in both the Master Plan and the development plan for the development priority area. The organization

for the project implementation, described in the section 5-13-1 for the development priority area, is proposed to continue to implement the projects in the Master Plan following the implementation of the project for the development priority area.

4-12-2 Project Implementation Schedule

The project implementation period is planned to be 20 years up to 2015, according with the terminal year, 2015, of the "Agricultural Development Master Plan".

In the first stage of development, the project for the development priority area of 973 hectares will be implemented. Following that, projects for other sites are to be implemented divided into 3 or 4 stages. The priority of development sites is studied in the Table 4-3-3 of the section 4-3-3, in which sites evaluated as A are in general more advantageous than those evaluated as B. However, the willingness and ability of participating villages and farmers for the development, which are very important for successful accomplishment of irrigated agriculture, should be confirmed to be taken into consideration to select the development sites to be implemented in a development stage. Especially, this point is stressed for Bocanda site irrigated by pumping water from the N'Zi river and for Baa and Katié sites irrigated by tributary dams, because of their difficulties compared with other sites. Their difficulties are points that the former needs skillful operation and maintenance of pumping equipment and a considerable expenditure of pumping operation, and the latter two are of large scale development, which needs to secure and organize large number of participating villages and farmers.

When development sites to be planned for a development stage are selected, the feasibility study relative to these sites will first be conducted, then the detailed design and the implementation will follow. The implementation schedules for different sites are almost the same as those given in the section 5-13-2 for the development priority area, except for the Baa site, which needs a longer implementation period due to its larger dam construction scale. The Table 4-12-1 shows implementation schedules for the Bocanda pump-irrigated site, tributary dam sites other than Baa and the Baa tributary dam site.

Table 4-12-1 (a) Implementation schedule (Pump-irrigated site, Bocanda)

Items	1 st year	2nd year	3rd year	4th year	5th year	6th year	7th year
[Construction Works]							
Topographical & Geological Surveys		Bid					
Detailed Design							
Irrigation & Drainage Works		Prep	Main	Rubber			
_ Low dam		Prep	Main	Pump			
_ Pumping Stations & Conveyance Pipes		Prep	Main				
_ On-Farm Works							
Storehouses & Mills							
Agricultural Machinery							
[Supporting services]							
Organization of Farmers							
Extension Services							
Training of Farmers							
Fund for Farming Credit							

Table 4-12-1 (b) Implementation schedule (Tributary dam sites without Baa)

Items	1 st year	2nd year	3rd year	4th year	5th year	6th year	7th year
[Construction Works]							
Topographical & Geological Surveys		Bid					
Detailed Design							
Irrigation & Drainage Works		Prep	Main	Test			
_ Dams		Prep	Main				
_ On-Farm Works							
Storehouses & Mills							
Agricultural Machinery							
Rural Roads							
[Supporting services]							
Organization of Farmers							
Extension Services							
Training of Farmers							
Fund for Farming Credit							

Table 4-12-1 (c) Implementation schedule (Tributary dam site, Baa)

Items	1 st year	2nd year	3rd year	4th year	5th year	6th year	7th year
[Construction Works]							
Topographical & Geological Surveys		Bid					
Detailed Design							
Irrigation & Drainage Works		Prep	Main		Test		
_ 1 Dam		Prep	Main				
_ On-Farm Works							
Storehouses & Mills							
Agricultural Machinery							
Rural Roads							
[Supporting services]							
Organization of Farmers							
Extension Services							
Training of Farmers							
Fund for Farming Credit							

Notes: Bid; Bidding, Prep; Preparatory work, Main; Main work, Rubber; Installation of rubber dams, Pump; Installation of pumps, Test; Water-storing test

4-13 Project Evaluation

4-13-1 Purpose of the Evaluation

The purposes of the Master Plan are classified into three main categories; (1) to contribute to the government's self-sufficient food policy by increasing the production of rice and other foods, (2) to contribute to the improvements of the farming villagers' income, nutrition and living standards, and (3) to contribute to the promotion of local economy and to the increase of employment opportunities by invigorating the production, processing and marketing of the agricultural products.

The evaluation of the Master Plan areas examines if they serve adequately the above mentioned purposes and provides the economic indexes to select the priority areas from the Master Plan areas. The areas on which this evaluation is based are 2 areas in the main stream development plan and 17 areas in the tributary stream development plan.

4-13-2 Economic Internal Rate of Return

The economic internal rate of return in each Master Plan area is found as follows:

Development sites	Number	Area of development (ha)	Economic internal rate of return (%)
Sites along the tributaries' dams	17	3,685	3.2~11.4
Sites along the N'Zi main stream	2	953	7.5~8.3
Total	19	4,638	

Note : Refer to Table 4-3-3-for the values of EIRR per site

The sites irrigated by the tributaries dams show a considerable range in the rate of return from 3.2% to 11.4%, which presumably resulted from the relative differences of the dam construction cost per hectare, which in turn depends on the geographic conditions. Both of the sites along the N'Zi main stream show approximately 8%, which are irrigated by pumps.

4-13-3 Effects on the Social Economy

(1) Increased Production of the Main Crops

The increased production of rice and vegetables will contribute to the improved rate of self-sufficiency of these crops which are now imported. Suppose 80% of the development area is allotted to the paddy rice cultivation with the planting rate of 170%, the rice production of approx. 30,000 tons per year is expected, which equals to approximately 4% of the recent annual rice production of 700,000 tons in Côte d'Ivoire.

(2) Improvement of the Local Economy of the Farming Villages

Since coffee and cacao, which are important export and cash crops, were stagnated, the farm economy has been deteriorated. The production of rice and vegetables as cash crops will improve the poor economic conditions and will hopefully lead to the increase of consumption and investment and, consequently, the improvement of economy in the local area as a whole.

(3) Promotion of Agriculture-Related Industries

The promotion of the industries associated with agriculture in general, sales of the agricultural products and sales and production of the farm inputs are expected after the implementation of the project. In addition, 35% of the project operating expenses will be raised in domestic currency, which means that the equivalent amount of domestic materials and equipment will be purchased, therefore leading to the promotion of all related industries.

(4) Creation of Employment

After the implementation of the project, a large number of employment opportunities will be created, mainly because the labor force for the agricultural production and construction are necessary for the successful implementation of the project. In all the areas, it is expected that 915,000 man-days for the annual agricultural labor and 3,280,000 man-days for the construction work during the construction period will be created as employment opportunities.

Especially in the tributary stream dam areas where the non-cultivated land is to be cultivated, excellent farming land will be created and provided to the younger generations who, under the present conditions, must earn their living outside of their home villages. "To bring back the younger generation to the farming villages" is one of the primary goals of the Côte d'Ivoire Agriculture Master Plan.

5. DEVELOPMENT CONCEPT FOR THE PRIORITY DEVELOPMENT AREAS

CHAPTER 5 Development Concept for the Priority Development Areas

5-1 Priority Development Areas

5-1-1 Selecting Priority Development Areas

(1) Basic Approach

According to the S/W of the survey, priority development areas, encompassing a total land area of 1,000 hectares, are to be selected from the survey area and studied for feasibility.

It seems appropriate that the Master Plan for the agricultural development of the survey area focuses on the development of irrigation farming, especially that for rice cultivation, upon examining comprehensively the agricultural policies of the Côte d'Ivoire Government, the suitability of the development for the area's climatic and geographical conditions, conditions of the water resources that can be used for irrigation, and the profitability of the crops. Since priority areas are to be positioned as model sites in the Master Plan, they will be selected according to the basic approach described above.

To develop irrigation systems in the survey area, four methods are technically possible, which are compared and examined in Sections from 4-3-2 to 4-3-5 in Chapter 4.

Irrigation development along the N'Zi River

(a) Irrigation by drawing water directly from the main stream without creating a reservoir.
(b) Irrigation by using water collected in a low dam built in the low water section of the N'Zi River
(c) Irrigation and flood control for almost all areas along the N'Zi River that are suitable for development by creating a large dam in the upper stream.

Irrigation development along the branches of the N'Zi River

(d) Irrigation and flood control for almost all areas along the branches of the N'Zi River that are suitable for development by creating small dams in the branches.

As mentioned in Chapter 4, Section 4-3-5, it is appropriate to start with small-scale development and then construct a large dam (plan no. 3 of the above) in the last stage of irrigation development in areas where slash-and-burn agriculture is still prominent and irrigation farming is hardly popularized. Based on this principle, priority development areas of a total acreage of 1,000 hectares are chosen from small-scale development areas.

(2) Selection Criteria

Priority development areas are examined comprehensively and selected based on the following criteria:

(a) Scale: Development scale that is too small for the implementation of the project should be avoided.

(b) Economy: Investment efficiency (annual discount rate of 5%) of 1.5 or higher is preferred.

(c) Soil condition: Should be suited for irrigation.

(d) No. of communities: The area and its environs should have enough villages or people to participate in the project.

(e) Environmental protection: Areas that include protected forests should be excluded from the choice. Areas that include protected forests in their vicinities should be avoided as much as possible.

(f) Obstacles: Areas where reservoirs to be created by the project would make existing villages or main roads go under water should be avoided.

(g) Publicity/access: The areas should have an easy access to main roads as to ensure a good publicity effect, a smooth execution of the project and an easy transport of materials and products. However, this criterion should not be considered as important as others in the total evaluation since access roads are scheduled to be constructed as needed.

(h) Experience in irrigation farming: Communities that have experience in rice cultivation and are enthusiastic about continuing rice farming are given priority.

(3) Selecting Priority Development Areas

In the survey area, the pump-irrigated farm near M'Bahiako City is the only site that is currently conducting irrigation rice farming. Although it seems more advantageous for the most part in terms of economy and easy maintenance/operation in the future to develop along the branches of the N'zi River with method-4 than drawing water from the main stream with method-1 and 2, the fact that the farmers' organizations in M'Bahiakro has 20 years of experience in managing irrigation facilities following their completion and have been functional and continuing farming despite frequent breakdowns of old pumps and a lack of operational funds is notable. In addition, M'Bahiakro project can serve as a model site for areas that are remote from branches, which are suitable for dam construction, and may adopt the method of drawing water from the main stream of the N'Zi River in the near future. Therefore, the M'Bahiakro site is selected as one of the priority development areas based on the following criteria, which are explained in section (2):

(a) Scale: The entire cultivation area of 453 hectares (of which, 432 hectares are irrigated)

is to be included. The site is divided into seven irrigation blocks, each of which has a separate irrigation system and is run by an independent farmers' organization. In this improvement project, the site can be divided into two or more irrigation blocks whose sizes are suitable for the development.

(b) Economy: As it is an improvement project of existing facilities, the construction cost will be relatively low, thus the investment efficiency will be high.

(c) Soil condition: The soil condition is very good as the irrigation suitability index is 1 (extremely suitable) or 2 (mostly suitable).

(d) No. of communities: As the site is uniquely located near M'Bahikro City, many participating farmers live within the city and others commute to the site from neighboring villages. A sufficient number of farmers are expected to participate in the project as those already engaged in farming would likely expand their organizations in the future.

(e) No problems are found concerning environmental protection and obstructions.

(f) Publicity/access: As the site is located adjacent to M'Bahikro City, it is highly visible and accessible.

(g) Experience and enthusiasm in irrigation farming: As mentioned earlier, this is the only site in the survey area where people are experienced in irrigation farming and enthusiastic about continuing the operations.

As for selecting priority areas, 28 districts that are deemed technically possible to adopt the tributary-development method described in section (1)-4) were selected to be examined according to the selection criteria laid out in section (2). Of the criteria, no. 8 (experience in irrigation farming) was excluded as no sites except M'Bahiakro, including those suitable for tributary development, have experience in irrigation farming. Of the eight sites that were ranked "A," four including Dienzou, Yanmon, Eholié and Atofou were selected upon considering their balanced disposition to achieve maximum publicity, which are included in the survey area of 150,000 hectares.

Table 5-1-1 Selection of priority development areas along the tributaries of the N'Zi River

	Site (River)	Priority area selection criteria										Total evaluation	
		Scale (ha)		Economy (B/C)		Soil condition	No. of villages		Environ-ment	Obstacles, etc.	Demons-tration /access		
Right-bank tributaries of the N'zi River (irrigation area: 1,560 hectares)													
1	Yabue N'zue	A	150	C	0.8	B	C	0	A	A	B	C	
2	Sounglou	A	260	B	1.4	B	C	0	B	A	C	C	
3	Toualakoun	A	90	C	0.7	B	C	0	A	A	C	C	
4	Seke Gloutouha	A	250	A	2.6	B	B	2	A	A	A	B	
5	Katie	B	550	A	3.2	B	C	1	A	A	A	C	
6	Mandia	A	110	C	0.7	B	B	1	A	A	A	C	
7	Mo	A	40	A	2.7	A	A	2	A	C	A	C	
8	Akpobo	A	25	C	0.9	A	A	5	A	A	A	C	
9	Dienzou	A	60	A	2.0	A	A	2	A	A	A	A	©
10	Djamala	A	25	C	0.9	A	A	4	A	A	A	C	
Left-bank tributaries of the N'zi River (irrigation area: 2,295 hectares)													
11	Baa	C	970	A	2.9	A	A	5	A	A	B	C	
12	Yanmon	A	40	A	1.6	A	A	3	A	A	A	A	©
13	Pokoukia N'zueba	A	30	A	2.8	A	A	3	A	C	C	C	
14	Bassia	A	30	A	1.5	A	A	2	C	C	C	C	
15	Sokpa Yanmien	A	65	B	1.3	A	A	4	A	A	A	B	
16	Abode	A	50	A	2.5	A	A	1	A	A	B	B	
17	N'blinzueba	A	30	A	2.3	A	A	2	A	A	B	B	
18	Baya	B	520	A	3.1	A	A	4	A	A	C	C	
19	Bâa	A	30	A	1.5	A	C	0	A	A	B	C	
20	N'ziminou	A	80	A	2.8	A	B	1	A	A	B	B	
21	Eholie	A	100	A	1.5	A	A	2	A	A	A	A	©
22	Boudasse	A	70	A	2.5	A	B	1	A	C	A	C	
23	N'diti	C	10	A	2.7	A	C	0	A	A	A	C	
24	Kpokpla	B	20	B	1.4	A	C	0	A	A	A	C	
25	Atofou	A	110	A	3.2	A	A	2	A	A	A	A	©
26	Damin	A	100	A	1.9	A	A	2	B	A	A	B	
27	Songan	A	30	B	1.2	A	A	1	C	A	A	C	
28	Ebinmolo	C	10	B	1.3	A	A	1	A	A	A	C	

Note:
Total evaluation: A; good, B; medium, C; bad ©: priority area
Scale: A; 30 ha. or larger, B; 10-20 ha., C; less than 20 ha.
Economy: A; 1.5 or higher, B; 1.0-1.5, C; less than 1.0
Soil condition: A; irrigation aptness 2 (mostly suitable),
B; irrigation aptness 3 (barely suitable)
No. of communities: A; has sufficient labor force, B; is slightly short of laborers,
C; short of laborers
Environmental protection: A; other than B and C, B; adjacent to protected forest,
C; the site includes protected forest.
Obstacles, etc.: A; other than C,
C; If reservoir is constructed, main road or village will go under water.
Demonstration effect/access: A; good, B; medium, C; bad

5-1-2 Outline of Development Plan for Priority Areas

(1) Outline of Priority Development Areas

Of the total development acreage of 973 hectares in the priority areas, 882 hectares will become an irrigated farmland and 91 hectares a non-irrigated farmland. Number of farming households that will directly benefit from the development is estimated at 1,340 households (8,330 people).

Outline of the priority development areas are shown in Table 5-1-2.

Table 5-1-2 Outline of the priority development areas

Sites	M'Bahiakro	Dienzou	Yanmon	Eholie	Atofou
Area of development (ha)	453	110	80	130	200
- Irrigated land	432	90	65	105	190
- Non-irrigated land	21	20	15	25	10
Irrigation method	Low dam (headwork) and 2 pumping stations	Gravitational irrigation from reservoirs built along the tributaries			
Relevant villages	M'Bahiakro Akrifoukro Ouakoukro Abokro Ndjolekro Gbangbo-Kouassikro Dangou Adi Yapikro	Kouadianikro Boore-Akpokro Boore-Ettienkro Bangokro	Cbanan-Koffikro Abongnikro Klomikro	Assie-Kokore Assie-Koyekro Assie-Koumassi	Ndrikro Kouakro Pronobo
Sub-District	M'Bahiakro	Dimbokro	Bocanda	Bongouanou	M'Batto Bongouanou
District	M'Bahiakro	Dimbokro	Bocanda	Bongouanou	Bongouanou
Populations of concerned villages	2,237	2,460	880	5,214	2,312

Note: The population of concerned villages does not include that of M'Bahiakro City.

(2) Content of Project

Construction Project

- Irrigation/drainage system:
  4 dams along the tributaries (Dienzou, Yanmon, Eholié, and Atofou)
  A low dam in the low-water section of the N'Zi River and drainage canals for 2 pumping facilities in M'Bahikro district
- Farmland to be developed: 5 districts, 973 hectares

- Post-harvest facilities: warehouses and rice mills
- Agricultural equipment: cultivators and threshing machines
- Farm roads: 28.9 kilometers
- Water supply for villages (wells with manual pumps):
  13 wells will be installed in 10 villages of the relevant communities.
- Others

Support Measures

- Farmers' organizations
- Promotion of cultivation and water-management techniques and relevant training
- Agricultural credit
- Others

5-2 Land Resources

5-2-1 Topography

The topography of M'Bahiakro area are characterized by alluvial plain of the N'Zi river, lower river terrace and plateau. The alluvial plain is almost flat with the elevation of 123 m in the north of the study area and 119 m in the south near M'Bahiakro. The lower river terraces are mainly observed in the north and the east of M'Bahiakro and are generally 2 - 3 m higher than the alluvial plain. The plateau is observed in the north of M'Bahiakro and has gentle slope (1 - 3%) in lower slope and rather steep slope (10 - 15%) near the top of the plateau. However, the northern edge of the plateau has steeper slope of around 30%.

The study areas of Yanmon, Dienzou and Atofou have similar topographical characteristics, consisting of alluvial valley of each river and middle and lower slopes of interfluves on the both sides of the valley. In Yanmon site, flat alluvial valley is observed on the both sides of the river. The width of the alluvial valley is narrow, 50 to 150 m. Unlike Yanmon site, flat alluvial valley of the Dienzou river exists either right or left of the river. The width varies from 50 to 200 m and is wider at confluences of small streams and the Dienzou river. The flat alluvial valley of Atofou river is the widest among the three, 300 to 400 m. The slope of the interfluves is in general 5 - 10%.

In Eholie area, the topography is characterized by alluvial plain and middle river terrace of the N'Zi river and plateau. The alluvial plain and middle river terrace occupy more than 50% of the study area. The alluvial plain is almost flat. The middle terrace has very gentle slope of about 1% toward the N'Zi river.