

The reason why only one social environmental component was identified relates to the fact that the project does not anticipate any relocation of people or resettlement of villages, and that it is merely constituted of small scale agricultural development schemes.

Matrix of impact Identification

Environmental component	Impact location		Impact stage		
	1	2	3	4	5
Change in surface water hydrology	XX			XX	XX
Negative impact on important or indigenous fauna and flora	XX	XX		XX	XX
Change in vegetation	XX	XX		XX	XX
Soil erosion	XX	XX		XX	XX
Increased use of agrochemicals	X	X		X	X
Deterioration of soil fertility	X	X		X	X
Water contamination and deterioration of water quality	X	X		X	X
Note 1. Impact location	1. Irrigation site along main stream (M'Bahiakro) 2. Irrigation site along tributary (Dienzou, Yamnon, Eholie, Atofou)				
Note 2. Impact stage	3. Pre-construction stage 4. Construction stage 5. Post-construction stage				
Note 3. XX	Significant environmental impact is unquestionably induced by the project				
X					
	Significant environmental impact is likely to be induced by the project				

3-2 Social Conditions

3-2-1 Population and Social Structure

(1) Population

According to the "Recensement General de la Population et de l'Habitat 1988", the total population of the seven (7) sub-prefectures where the survey was done is 357,726. Among them, 173,633 are male and 184,093 are female. The population density is 28.8 persons per km², which is considerably lower than that of the national average of 38.0 persons per km².

The annual population growth rate of the studied area is one of the lowest in the country. An analysis of data from the last three census periods demonstrates that there is a dramatic change in population growth between the periods of 1965 to 1975 and 1975 to 1988. The population growth rate from 1965 to 1975 was 4.66%, which was slightly

lower than the national average of 5.10%, while the period from 1975 to 1988 showed population growth of -0.71% when the national average was 3.7%.

The low population growth is due to the migration of young generation to the west and south west regions such as San-Pedro, Soubre, Sassandra, Tiassale etc. The estimation based on the national average of population growth rate shows that the number of people migrated during the period of 1975 to 1988 is estimated at 271,676 persons.

The population growth rates from 1965 to 1991 are shown in the table below.

Table 3-2-1 Population growth during 1965 to 1991

Sub-Prefecture / Year	Population (persons)				Average growth rate (%)	
	1965	1975	1988	1991..1/	1965 to 75	1975 to 88
Dimbokro	50,000	64,630	66,914	67,452	2.60	0.27
Bocanda	59,000	85,151	62,862	58,610	3.74	-2.31
Kouassi-Kouassikro	17,400	11,855	12,158	12,229	-3.76	0.19
Ouelle	21,000	40,806	27,592	25,210	6.87	-2.97
Bougouanou	49,800	93,094	84,527	82,665	6.46	-0.74
M'Batto	22,800	50,013	54,390	55,453	8.17	0.65
M'Bahiakro	28,800	46,919	49,283	49,846	5.00	0.38
Total	248,800	392,468	357,726	351,465	4.66	-0.71
Country(1,000)	6,736	6,736	10,799	12,242	5.10	3.70

Source; Recensement Général de la Population et de l'Habitat, (R.G.P.H), 1988

Note; The population of 1991 is estimated by R.G.P.H.

(2) Social Structure

The Agba, which is a sub-group of Baoule, is the major ethnic group of the studied area. The Baoule community is extremely migration-oriented. The migration pattern is classified into two categories. They are the long duration migration and the short-term seasonal migration. As for the long duration migration, it consists of the movement of the Baoule people toward suitable farm lands and urban centers where they can control more prosperous sectors. This type of migration implies that it prompts rural exodus and stimulates woman emancipation and contributes to educational development.

The Baoule people form a village based on groups of extended families which have kept the family structure since the initial settlement. The community structure is based on the kinship networks, which defines the life condition from its symbolical aspect in the village.

The village chief traditionally has a great authority over justice, administration and religion. The village community consists of the village chief and heads of the extended families. However, the village structure has been changing gradually under the influence of modernization.

As shown in Table 3-2-2, the study area includes two(2) regions, four(4) departments, seven(7) sub-prefectures, 395 villages and 2,462 camps.

Table 3-2-2 Administrative division in the study area

Regions	Departments	Sub-Prefectures	Area (km ²)	Villages No.	Camps No.
1. Center	1. Dimbokro	1. Dimbokro	1,586	69	19
		2. Bôcanda	2,185	104	348
		3. Kouassi-Kouassikro	1,188	29	4
	2. Daôukro	4. Ouelle	1,405	44	296
	3. Bougouanou	5. Bougouanou	1,520	40	1,292
		6. M'Batto	1,671	31	392
2. North Central	4. M'Bahiakro	7. M'Bahiakro	2,632	78	111
Total	4	7	12,187	395	2,462

Source: RECENSEMENT GENERAL DE LA POPULATION ET DE L'HABITAT, 1988

3-2-2 Rural Infrastructure

(1) Roads

The major trunk road network, which connects cities in the country, has been well developed being mostly composed of asphalt-paved roads with two lanes or more. In the study area, its most important trunk route of two lane asphalt-paved road connects Dimbokro situated in the southern-most of the study area and M'Bahiakro in the northern-most and the other trunk route, which connects Dimbokro with its east-neighboring Bongouanou department, runs along the left bank of the N'Zi river in the southern part of the study area.

Almost all villages are connected with the above-mentioned major trunk routes directly or through feeder roads or rural roads. Most of those feeder roads are of two lanes and of all-weather use being paved with laterite gravel and equipped with drainage facilities in inundation sections, although some remain in partially improved condition. Most of rural roads are of one lane and not fully practicable when it is rainy due to lack of improved surface and drainage facilities. However, even in case of rural roads, the road surface is mostly kept rather in good condition due to being formed with good-texture sandy soil and recovers practicability soon after rain has ceased and inundation has disappeared. In

addition, laterite gravel is found in near-by sites. Therefore, it seems that maintenance works can rather easily be done to maintain laterite-paved and earth roads in good practicability in the study area.

With regard to asphalt-paved trunk roads, DCGTx is responsible for planning, detailed design and supervision of execution and DDETT (Direction Departementale de l'Equiment, des Transports et des Telecommunications) is in charge of maintenance. As for feeder roads and rural roads, DDETT is fully responsible for planning, detailed design and supervision of execution and maintenance.

(2) Setting-up of Villages

A village is mostly composed of collectively residing population from 100 to 1000 and rarely of more than 2000. Villages are located on relatively high terraces along the N'Zi main stream or in tributary valleys, where there are no floods and drinking water and cultivable lands are easily available, being scattered with a distance from each other.

Most houses are made of sun-dried bricks or of earth walls with thatched or galvanized iron plate rooves. There is a meeting place in a village being situated under a shadow of big tree or made of thatched roof without walls. Primary schools are found in rather big villages and churches in some Christian villages.

All works for living including carrying and lifting drinking water, collecting woods from forests and husking and milling grains for food depend on manual labor. Shifting cultivation of yam, cassava, corn, rice etc. and cultivation of cacao and coffee are manually done by using simple agricultural implements.

(3) Water Supply for Drinking and Living

Well with a manual pump is equipped in every village (or two pumps or more in case of a very big village) for drinking water. Those wells can supply clean drinking water to villagers. Well depth is 60 m in average ranging from 20 to 100 m and its discharge is in the range of 0.5 to 60 m³/hr. Water is often taken from streams and ponds for such uses as washing clothes and bodies in case water supply wells are insufficient.

(4) Schools

Primary schools are extensively found in rural areas. School houses are rather tidy compared with village houses even though they are mostly built of sun-dried bricks, which is a popular material for houses in villages.

(5) Others

Electrification has not yet been practiced in rural areas except a few villages.

As for health care, several hospitals and clinics exist only in urban areas of Dimbokro, Bocanda and M'Bahiakro and some dispensaries in rural areas in the study area (Table 3-2-3).

Table 3-2-3 Present condition of rural infrastructures in the concerned sub-prefectures

Departments	Dimbokro			M'Bahiakro	Daoukro	Bongouanou
Sub-Prefectures	Dimbokro	Bocanda	Kouassi-Kouassikro	M'Bahiakro	Ouelle	Bougouanou
Area (km ²)	1,480	2,820	1,386	2,860	3,000	1,560
No. of Villages	72	100	30	76	37	40
No. of Inhabitants	66,914	62,862	12,158	47,522	17,192	84,527
- Urban	38,183	7,415	0	10,782	10,435	19,506
- Rural	28,731	55,447	12,158	36,740	6,757	65,021
Trunk Roads (km)						
- asphalt-paved	72	50	0	78	66	90
Sections						
- Feeder roads	475	492	351	274	371.5	840
Rural roads						
No. of Wells	125	145	40	70	74	90
No. of Schools						
- Primary	70	62		33	28	70
- Secondary	4	1		1	1	3
No. of Health Care Centres						
- Hospitals	1	1	0	1	1	1
- Clinics	2	0	0	2	0	0
- Dispensaries	9	3	1		1	6
- Doctors..	11	1	0	4	1	2

3-2-3 Rural Economy

This area acted as the major production area of coffee and cacao (called the Cacao Belt) during the period of high economic growth of Côte d'Ivoire. The most important industry was agriculture with an emphasis on production of such export products as coffee and cacao as the main source of income. However, after the 1980's, both cultivation area and the production of coffee and cacao declined because of various factors such as natural environmental conditions and the renewal period. Coffee and cacao lost their importance as cash crops, contributing less to the rural economy and export. In Dimbokro prefecture, for example, the sales of coffee and cacao decreased from 3,989t in 1989/90 to 374t in 1992/93, showing an approx. 90% reduction. Since the principal source of income is rapidly lost due to the decline of the two major cash crops, the farmers are starting to look into the possibilities of paddy and traditional crops as the new cash crops in place of coffee and cacao..

In association with the agricultural production, such agricultural processing industries as rice mills facilities are observed in the paddy-producing areas, particularly in Bongouanou department and others. Due to the growing attention on the paddy as cash crop, the rice milling industry is likely to expand in the future. In this area, a large-scale mill (industrial transformation) owned by a private rice milling company called SORIZCI (with the performance of 12t/h) is located in Bongouanou city. The mill remained out of operation for these few years but is gradually returning to its normal operation. Additionally, there are approximately forty small-scale rice mills (artisanal transformation) with the performance of 200kg/h in all the area added. And the number is said to increase to more than 50 if those rice mills with 600-1,000kg/h are included. About 63% of these small-scale mills are located in the two districts of Bongouanou and M'Batto.

In Dimbokro city, there is a textile company called UTEXI. The company was established in 1973 and has been contributing to the local employment, despite the fact that the present amount of cotton cultivation in this area is not very large. The number of employees of this company as of 1991/92 equals 1,090 and the amount of sales is approximately 13 billion CFA F.

3-3 Agriculture

3-3-1 Land Use

The study area involves six classified forests; Ahoua and Sanuan in the south, and

Tagba, Koumo, Kuiakro and Bossia Mori in the northern part.

In the study area, it is difficult to find fixed farms in a Japanese sense except for the irrigated rice fields and coffee and cacao plantations, because most annual crops including upland rice are grown in shifting cultivation system where the growing sites change year by year. Thus, the land use is not identical from year to another, hence can be considered only on the basis of sum total of seeded or harvested area of the year.

Cropping acreage and production volumes of major crops in the sub-prefectures concerned with study area in the agricultural year of 1992/93 are collected in Table 3-3-1 (source: the Activity Reports of Department Direction of the MINAGRA in the concerned departments). The sub-prefectures surveyed are: Dimbokro, Bocanda and Koussi-Kouassikro in Dimbokro department, M'Bahiakro in M'Bahiakro department, Bongouanou and M'Batto in Bongouanou department and Ouelle in Daoukro department.

It is noticed that more than half of the cropping area is occupied by coffee and cacao plantations in every sub-prefecture, attaining 90 % or more in those in the Department of Bongouanou. Regarding food crops, the dominant ones are rice and maize as cereals, and yam and cassava as tuber crops. Vegetable and fruit productions occupy only very minor position today.

The production volumes of certain crops in Table 3-3-1 are not always reliable because expected productions are sometimes given by simple multiplication of cropping acreage by theoretical yield.

Table 3-3-1 Agricultural production of 1993 in sub-prefectures concerned with the study area

Department		Dimbokro			M'Bahia - kro	Bongouanou		Daou - kro
Sub-prefecture		Dimbokro	Bocanda	Kouassi-Kouassikro	M'Bahia - kro	Bongouanou	M'Bato	Ouellé
Irrigated rice	Area (ha)	18.25	-	-	226	(-)		-
	Production (t)	73*	-	-	169.5	(-)		-
Rain-fed rice	Area (ha)	291.5	600.25	99.5	530	(6,548.3)		731
	Production (t)	437*	900*	149*	225	(N.A.)		592
Maize	Area (ha)	332	415.5	124.5	487.5	(4,539)		662
	Production (t)	N.A.	N.A.	N.A.	226.5	(N.A.)		2,569**
Yam	Area (ha)	546.8	595.5	151	693	(1,721.8)		695
	Production (t)	N.A.	N.A.	N.A.	3,509.5	(N.A.)		N.A.
Cassava	Area (ha)	306.25	100	22	77	(304.5)		54
	Production (t)	N.A.	N.A.	N.A.	431	(N.A.)		N.A.
Peanut	Area (ha)	182.5	174.3	68.5	351	(271.8)		193
	Production (t)	N.A.	N.A.	N.A.	196	(N.A.)		N.A.
Coffee	Area (ha)	3.442	3,716	-	3,782	10,262	10,397	1,700***
	Production (t)		(296)		2,439	(943.3)	(943.3)	(23)
Cacao	Area (ha)	-	500	-	(1,412)	7,500	4,300	3,094***
	Production (t)		(151)		N.A.	(11,393)	(11,393)	(1,753.5)
Cotton	Area (ha)	34	186	11	269.5	176.5	317.0	87.5
	Production (t)	17.5	157.1	12.6	254.4	118.6	191.0	51.7
Vegetables	Area (ha)	14.84	2.75	-	13.05	34.1	10.5 (90/91)	224.3
Fruit trees	Area (ha)	53.9	24.86	-	N.A.	53.2	14	5

Remarks : *: Estimated production, **: Tonnage before threshing, ***: Values including Sub-prefecture of Ettokro, (-): Values for the Department.

3-3-2 Cropping Patterns and Farming Practices

Habitual cultural season and growing period of the major crops are illustrated in Fig. 3-3-1. It is found that most annual crops are grown in rainy season even in case of irrigated rice.

Typical examples of cultural systems observed in the study area are summarized in the diagram in Fig. 3-3-2. The cultural systems are classified in two types; intensive or modernized type and extensive or traditional type. However, the former intensive type still remains exceptional.

In case of rice culture, for example, intensive system is practiced at only two localities; perimeter of Adahou (20 Ha) in Dimbokro department and perimeter of M'Bahiakro (422 Ha) in M'Bahiakro department. It should be noticed that even farmers in those modernized perimeters have never succeeded normal double cropping of rice, due to river flood, deficit of irrigation water, troubles of pumps and agricultural machines, shortage of man-power and/or finance and so on. Intensive culture of cotton is literally exceptional in this region.

The people's basic food of the region is yam followed by cassava and maize. Rice is generally grown as a cash crop or as a complementary food in the off-season of yam. Furthermore, shifting cultivation system with "slash-and-burn" is traditional practice of growing majority of food crops. In the traditional system, associated cropping is also commonly practiced. For example, upland rice is generally grown in association with maize, and yam with cassava, maize, okra, peanut, fruit and plantain banana, and others (Annex D-1). After a few years' cultivation, farmers let the farms in fallow during 3 - 5 years, sometimes up to 20 years. One of the remarkable features of food crop production in the study area is absence of systems containing upland rice and yam simultaneously, though recommended in most technological guide books (for example, "Le Riz Pluvial", Maisonneuve & Larose, 1983; "Le Riz Pluvial", INADES Formation, 1983; "L'Ignome", INADES Formation, 1989, etc.) as favorable ones. In the present situation, rain-fed rice and yam are found in separate systems, though grown in similar practice of shifting cultivation with slash-and-burn. Probable cause of it would be attributed to the fact that rice has been introduced more recently in the region as compared with other food crops. On the other hand, the traditional way of growing yam in association with cassava practiced by most farmers is to harvest yam in the first year and cassava in the next year. This type of practice has been criticized in the technological guide books (for example, "L'Ignome", INADES Formation, 1989) by the reason of unfavorable competition in soil nutrients between two tuber crops. Apart from the agronomical point of view, however, it must be

Figure 3-3-1 Cropping cycles of major crops

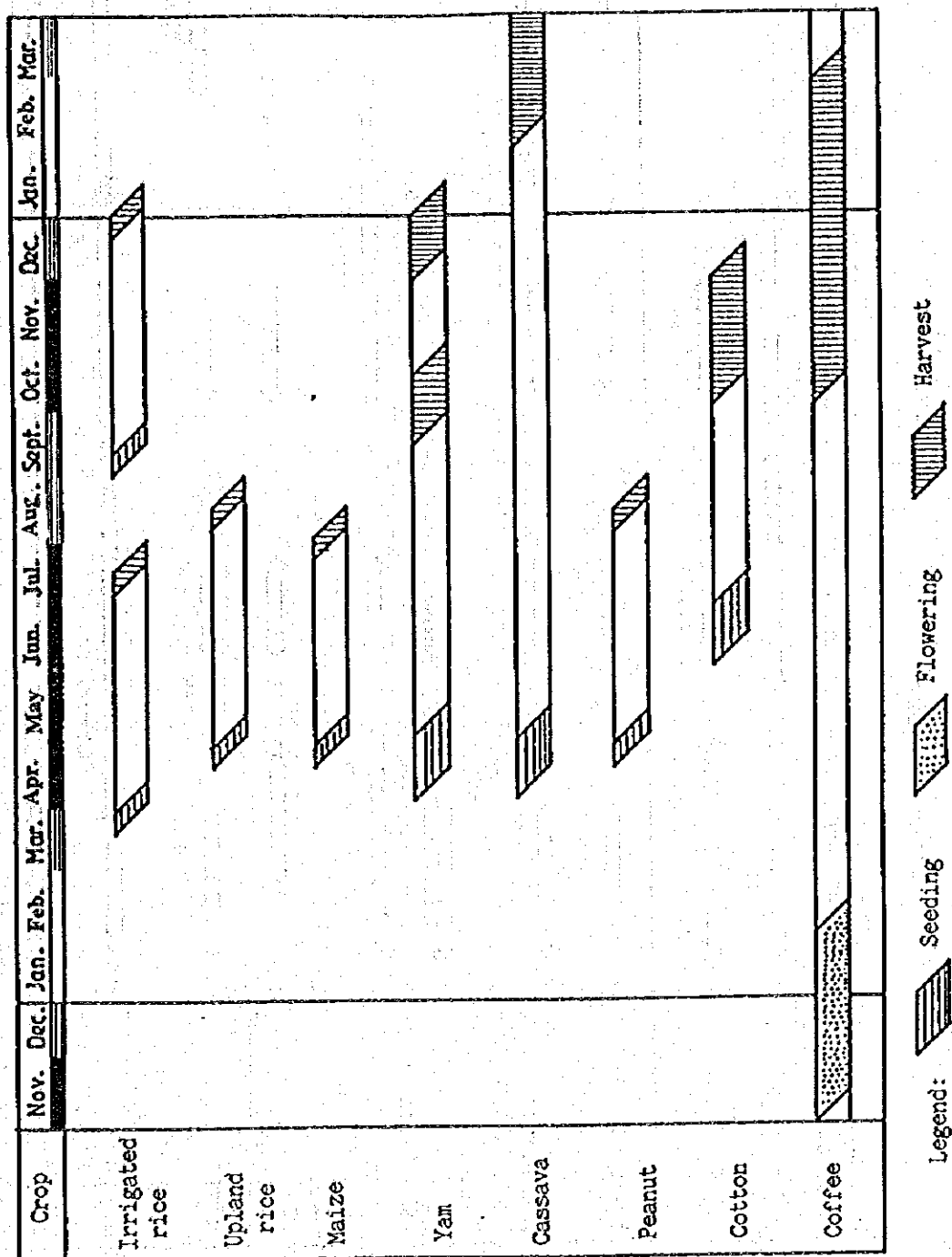


Figure 3-3-2 Typical cultural systems of food and industrial crops
(Present situation)

Type	1st year	2nd year	3rd year	4th year
Intensive	<div> <div> <div>↔ Rice</div> <div>↔ Rice</div> </div> <div> <div>↔ Maize</div> <div>↔ Cotton</div> </div> </div>	<div> <div>↔ Rice</div> <div>↔ Rice</div> </div> <div> <div>↔ Peanut</div> </div>	<div> <div>↔ Rice</div> <div>↔ Rice</div> </div> <div> <div>↔ Maize</div> </div>	<div> <div>↔ Rice</div> </div>
traditional	<div> <div>↔ Rice</div> </div>	<div> <div>↔ Rice</div> </div>	<div> <div>↔ Rice</div> </div>	<div> <div>Fallow (5 years)</div> </div>
	<div> <div>↔ Rice + Maize</div> </div>	<div> <div>↔ Rice + Maize</div> </div>	<div> <div>↔ Rice + Maize</div> </div>	<div> <div>Fallow (5 years)</div> </div>
	<div> <div>↔ Yam + Maize etc.</div> </div>	<div> <div>↔ Maize</div> </div>	<div> <div>↔ Maize</div> </div>	<div> <div>Fallow (10-20 years)</div> </div>
	<div> <div>↔ Cassava</div> </div>	<div> <div>↔ Maize</div> </div>	<div> <div>↔ Cassava</div> </div>	<div> <div>Fallow (3-5 years)</div> </div>
Cotton culture	<div> <div>↔ Cotton</div> </div> <div> <div>↔ Rice</div> </div>	<div> <div>↔ Peanut</div> </div> <div> <div>↔ Maize</div> </div>	<div> <div>↔ Maize</div> </div> <div> <div>↔ Peanut</div> </div>	<div> <div>Fallow (3-5 years)</div> </div> <div> <div>↔ Cotton</div> </div>
Coffee				
Cacao				
	Harvest	Harvest	Harvest	Harvest
	Small harvest	Harvest	S. Harvest	Harvest S. Harvest Harvest

↔ : Burning

originated from the experiences and wisdom accumulated by the rural people to assure their subsistence. Even if the shifting agriculture, common practice in the study area, was certainly rooted on people's tradition developed and inherited through long history, it should be pointed out that this type of agriculture always accompanies low efficiency in land use as well as in crop productivity, and often meets the risks to destroy forests and other natural vegetations due to occasional bush fires.

Moreover, the aridification tendency of climate since 1970s, together with the unstable rainfall changing annual and monthly precipitation every year, gives the causes of frequent droughts accompanied with serious damage of agricultural production. Actually, the study area has suffered from five big droughts in recent two decades; that is, in 1977, 1983, 1986, 1990 and 1992. In Dimbokro department, for instance, the harvested acreage of most crops diminished to less than half of seeding area by the drought in the year 1991/92 as shown in Table 3-3-2 (The Activity Report of Department Direction of Dimbokro, 1992; Report on Agriculture in the Department of Dimbokro, 1989-1993, October 1993). The main cause of crop damage, however, was not always the general decrease in annual rainfall in this year, but the unfavorable distribution, that is, extremely low precipitation in June and August.

Table 3-3-2 Cropping area before and after the drought of 1991/92 (ha)

	Rain-fed rice	Corn	Yam	Cassava	Peanut	Cotton
Seeded area	1,121	1,271	2,576	679	623	280
Harvested area	627	657	1,392	407	425	231
Rate of damage (%)	44	48	46	40	32	18

So far, the region involving study area has been called "Cacao belt" (La Boucle du Cacao) because it was the biggest producer of cacao and coffee of this country in the colonial age. In contrast to the name, coffee and cacao production in this region shows considerable decline in recent years. Thus, the trend in dealing amount of coffee and cacao in Dimbokro department clearly shows a real regression; 3,989 t in 1989/90, 3,791 t in 1990/91, 1,476 t in 1991/92 and finally 374 t in 1992/93 (Department Direction of Dimbokro: Report on Agriculture in the Department of Dimbokro, 1989-1993, October 1993). Main factors of this decline are explained as follows (Ivoirian Association of Agricultural Sciences: *Aperçu des Activités Agricoles dans "La Boucle du Cacao"*, 1986):

- Aging of plantations. More than 46 % of the coffee and cacao plantations are 25 years old

or more.

- Parasites. Old plantations are more susceptible to the attack of parasites (mirides, locusts, squirrels, phytophthora etc.).
- Attack of drought, particularly in 1982/83, accompanied with bush fires in the drought condition.
- Progressing degradation of forests, which restricted the extension of productive plantations.
- Aging of producers in relation to the decrease of man-power supplied traditionally by migrating foreign people.
- Problems of agricultural credit.
- Political decision to suspend the further extension of coffee plantations on national level.

In fact, the pyramid of tree age of coffee plantations in Dimbokro department indicates that more than two thirds of the coffee trees were planted before 10 years or more as shown in Table 3-3-3. Furthermore, according to the ANADER experts in Dimbokro, most part of those old trees are 30-40 years old. As regards to the bush fires occurred under the conditions of big drought of 1982/83, about 75 % of coffee and cacao plantations were burnt and destroyed in Daoukro department, and 183 ha in the sub-prefecture of Dimbokro, Dimbokro department, disappeared by the fire.

Table 3-3-3 Age pyramid of coffee trees in Dimbokro department

Year of planting	Area	
	ha	%
1950 - 1984	2,432	67.9
1984 / 85	8	0.2
1985 / 86	39	1.1
1986 / 87	40	1.1
1987 / 88	90	2.5
1988 / 89	70	2.0
1989 / 90	326	9.1
1990 / 91	470	13.1
1991 / 92	67	1.9
1992 / 93	40	1.1
Total	3,580	100.0

Notwithstanding the critical situation mentioned above, the germs of agricultural innovation are to be found in the study area. Rice growers in the perimeters of Adahou and

M'Bahiakro are making continuous efforts to apply the modern technologies to their rice culture as indicated in Table 3-3-4. Noteworthy is that they use motor cultivators to plow and apply chemical fertilizers as much as 50-60 % of Japanese standard. So, it is very hopeful that their efforts would bear good fruits by attaining to the productivity level similar to an excellent model perimeter of La Loka in Sakassou department.

3-3-3 Animal Production

The present situation of animal husbandry in the study area is still primitive as shown in Table 3-3-5 (the Activity Reports of Department Direction of the concerned Departments). Stagnation can be seen not only in small number of animal heads but in rate of organization by the ANADER; only 50 % by cattle and 4 % by sheep and goats in Dimbokro department. The major races are Baoule and N'Dama, both resistant of trypanosis, by cattle, and Djallonke by sheep, both being raised by quite extensive method in most cases. Poorly developed state of animal husbandry in this region seems to be resulting from the lack of tradition of breeding animals, surprisingly high price of calves, advanced aging of animal breeders and so on. Moreover, the ANADER continues the efforts to encourage, improve and well organize the animal husbandry of the region. According to the ANADER experts, the fly tse-tse is not an important constraint nowadays, if not completely eliminated.

As concerned with fishing and fish culture, the general aspect is similar to animal husbandry. Most of registered fishermen of N'Zi river are foreigners from Mali, and the native people catches fish only occasionally in the off-season of agricultural activities to cover their family demand. Moreover, the catch of fish is not stable, particularly in years where water level of N'Zi lowers due to deficit of rainfall. For example, the fishing product was practically nothing in 1992/93, a serious drought year (the Activity Reports of Department Directions of Dimbokro and M'Bahiakro). Ponds for fish culture have been created in some place, but few in number and without production in most cases (Table 3-3-5).

Table 3-3-4 Technological practices in the existing irrigated perimeters (1993)

	Adahou (Dimbokro département)	M'Bahiakro (M'Bahiakro département)	La Loka(Reference) (Sakassou département)
Variety employed	Bouake 189 (135 days)	Bouake 189 (135 days)	Bouake 189 (110 - 120 days)
Soil preparation	Manual or motor cultivator, June - late July	Disc plow once, Motor cultivator twice	Motor cultivator (14 HP) twice, 0.6 ~ 0.8 ha/day
Seeding	Hill seeding by spacing 20 - 25 cm. Amount of seeds: 40 kg/ha, June - late August	Broadcasting, 80 kg/ha 1st crop: 15 Mar.- 15 May 2nd crop: 15 Aug.- 15 Sep.	Broadcasting, 50 - 60 kg/ha
Fertilizer:			
Basic dressing	NPK (10-18-18) 150kg/ha	NPK (10-18-18) 100kg/ha	NPK (10-18-18) 150kg/ha
Top dressing	1st Urea 40kg/ha, at early tillering stage 2nd Urea 47kg/ha, at late booting stage	1st Urea 50kg/ha, at early tillering stage 2nd Urea 25kg/ha, at late booting stage	1st Urea 50kg/ha, 21 days after seeding 2nd Urea 50kg/ha, 60 days after seeding
Weed control	Manual weeding	Herbicides (Ronstar, Basagran, Galil, Tamariz + Herbazol) + Manual weeding	Herbicides (Basagran 61/ha, Galil 51/ha) + Manual weeding
Pest control	Insecticide, ONCOL 25kg/ha if necessary. No insecticide was applied in 1993.	Insecticide (Furadan 5G, 3G), but quite rare	Insecticide (Sumithion 11/ha, STAC 0,5 l/ha)+ Bird control
Harvest	Manual	Harvest or manual 1st crop: from 8 June 2nd crop: from 31 Jan.	Harvest or manual
Double cropping	No, due to problems on machines and labor.	Yes, due mainly to failure of 1st crop.	Yes, entirely.
Cropping area	18.25ha	142ha (1st crop) 84ha (2nd crop)	370.5ha (1st crop) 376.4ha (2nd crop)
Average yield	3.0t/ha	0.75t/ha, extremely low yield was due to water deficit	4.83t/ha (1st crop) 3.33t/ha (2nd crop, attacked by virus disease)

Source : Hearing from the GVC and GI of the concerned perimeters.

Table 3-3-5 Present situation of animal production in sub-prefectures concerned with study area

Department		Dimbokro			M'Bahia - kro	Bongouanou		Daoukro
Sub - prefecture		Dimbo - kro	Bocanda	kouassi- Kouassi - kro	M'Bahia - kro	Bongoua - nou	M'Batto	Ouelle
Cattle	Number of parks	16	8	-	(9)	(7)		(15)
	Organized heads	3,080	846	-	(2,079)	(377)		(999)
	Total heads		(7,500)		(3,249)	N.A.		N.A.
Sheep	Number of parks	20	2	1	(11)	(53)		(37)
	Organized heads	1,019	61	189	(2,394)	(2,367)		(3,025)
	Total heads		(36,000)		(16,897)	N.A.		N.A.
Goat	Total heads	4,993	7,572	-	N.A.	(1,698)		(5,656)
Pig	Number of parks		(-)		N.A.	(2)		(-)
	Organized heads					(481)		(-)
Broiler hens	Number of parks		(1)		N.A.	(-)		(-)
	Organized heads		(14,659)			(-)		(-)
Egg hens	Number of parks		(-)		N.A.	(1)		(1)
	Organized heads							
	Chicks		(-)		N.A.	(-)		(600)
	Hens		(-)		N.A.	(8,798)		(-)
Fish culture	Number of enter - prises	4	3	-	-	13	9	(2)
	Number of ponds	31	12	-	-	28	9	(9)
	Area (are)	922	237	-	-	N.A.	N.A.	(26)
	Production	-	-	-	-	-	-	(-)

Remarks : () Values for the Department.

3-3-4 Agro-Economy

(1) Farm Economy

(a) General Situation

A Farm Economic Survey on 100 farm households in 25 villages in the survey area was carried out in October 1993. The result of the survey shows that one farm household (including several families) contains the average of 6.23 individuals and 2.54 potential workers. The size of the farming land owned by one household was not made clear from the data, but the average size of the cultivated area per household is 2.49ha, which is divided into 0.98ha for maize, 0.81ha for yam, 0.23ha for coffee, 0.17ha for paddy, 0.17ha for cassava and 0.13ha for cacao. Some mixed cultivations are observed, but specific data is not available. The head of the household is 38 years old on the average, of which 45% understand the French language and 35% have at least some education of middle school level.

(b) Employment and Jobs

Cultivation of such products for self-consumption as yam and maize as well as the cultivation of the cash crops or craft crops are the main productive activities of the area. There are almost no other job opportunities, and some seasonal and long-term emigrations of the young workers are observed. In some areas of the N'Zi River, the seasonal fishing applying the traditional methods is performed.

(c) Cultivation of Crops

Based on the survey result, the relationship of the main crops and the number of the cultivating farm households is shown in Table 3-3-6.

As shown in the table, yam is cultivated by all the households and is the primary crop. Furthermore, paddy is cultivated by 30% of the total households, and coffee is cultivated only by 15% of the households.

Table 3-3-6 Crop cultivation and farm number

Crops	Cultivation area (ha)	Farm number	% (Farm)
Coffee	23.49	15	15.2
Cacao	13.00	4	4.0
Paddy	16.93	30	30.3
Cassava	16.93	31	31.3
Maize	97.50	68	68.7
Yam	80.05	99	100.0
Total	201.55	99 farms	

Source: Farm Economic Survey, October 1993

The cultivation area per household is 2.49ha. Among them, maize occupies the largest 39.4% of the total cultivation area, yam occupies 32.6% and the paddy only 6.8%.

Table 3-3-7 Cultivation area per farm

Crops	Cultivation area (ha)	(%)
Coffee	0.23	9.2
Cacao	0.13	5.2
Paddy	0.17	6.8
Cassava	0.17	6.8
Maize	0.98	39.4
Yam	0.81	32.6
Total	2.49	100.0

Source: Farm Economic Survey, October 1993

(d) Farmers' Organizations

Although the activities of the GVCs, which center around the coffee and cacao, used to be quite active in the past, they have become stagnant in most of the villages at present. According to the Farm Economic Survey, the majority of the farm households are not enrolled in the farmers' organizations, with some regional differences in specific percentage. The enrollment rate in the GVCs amounts only to 33.3% even in the top-ranking Dimbokro prefecture.

Table 3.3.8 Participation rate to farmers' organization

District	GVC	Mutual aid	Both	No
Dimbokro	33.3	33.3	-	33.3
Daoukro	8.3	8.3	-	83.3
Bongouanou	-	50.0	-	50.0
Bongouanou	5.0	40.0	10.0	45.0

Source: Farm Economic Survey, October

(2) Land Tenure

As stated in the land tenure law in 1964, the land officially belongs to the government in Côte d'Ivoire. However, an automatic ownership right is given to whoever brings a piece of land into cultivation. That law is usually applied only to lands under direct government control such as national parks and classified forests. Actually, the owner-operated farms dominate the land tenure system in the study area as well as in the country. There are two types of land tenure. One is called "le certificat de la plantation," which is legally for perennial crop. The other is "le titre foncier," which is for all land uses. For cash crops, there is a form of sharecropping called in Baoule "ABUSSAN", a type of sharecropping in which the share cropper gets one third of the production, the rest being kept by the owner farmer. In rural areas where most of the lands are actually under the control of the rural communities, an outsider has to get permission from that community to have access to the land.

(3) Marketing and the Post-Harvest

The general marketing conditions of the primary agricultural products in the surveyed area are summarized below:

(a) Coffee.

There are two broadly classified marketing channels of coffee in this area. One is through the prefectural agricultural cooperative associations, and the other is through the private marketing agents. The handling share of these two channels, while differing from district to district, is divided almost equally into two in all the areas. However, it has been observed that the share of the cooperatives is decreasing due to the fund shortage of the cooperatives and the lack of the transportation means. The share of the private agencies are starting to grow.

The producer's price for coffee, which was 200 F.CFA/kg in January, 1994 at the time of currency devaluation, was raised to 275 F.CFA/kg in March and to 530 F.CFA/kg in September of the same year for the crop season of 1994/95. Likewise, the price for cacao was raised to 315 F.CFA/kg during the crop season of 1994/95.

(b) Cotton.

A stable production and sales of cotton can be expected, because the CIDT carries out a consistent production support ranging from the extension and cultivation guidance to the crop collection and shipment. However, in this district, the cultivation area for cotton is small compared to that for other crops. The producer's price for the first-grade cotton in 1993/94 was 105 F.CFA/kg, and it increased to 150 F.CFA/kg in the 1994/95 crop season.

(c) Paddy.

The paddy cultivation in this area mostly consists of the rain-fed cultivation of upland paddy. Though its yielding level is low, paddy has two important aspects. First, paddy can serve as the preservation food during the off-crop season of such staple food as yam and cassava. Second, paddy can be sold for cash. Paddy is mainly sold to the milling agents from outside the villages as well as to the buyers from the cities. The producer's prices of paddy and rice approximate 80 FCFA/kg and 150 F.CFA/kg (price before the devaluation) respectively, though the numbers vary according to such factors as the quality of the product, geographical conditions and shipment period. Paddy is sold mainly to the district merchants, but the agricultural cooperatives in Dimbokro prefecture have recently begun to buy it as well.

(d) Vegetables.

Many of the vegetables such as onions and tomatoes are delivered to the area from outside, and the in-area products are generally sold at the local market on a small volume. In Bongouanou prefecture, the vegetables are shipped to the wholesale market in Kotobi city, which is expected to play a more important role in the promotion of the vegetable cultivation in the future.

The prices of the agricultural products are subject to considerable seasonal changes, and the paddy and maize prices even double between the lowest and the highest (See Table 3-3-9).

Table 3-3-9 Monthly fluctuation of retailer prices in the Dimbokro market

Crops	Month	Aug.- Oct. F.CFA/kg	Nov.- Jan. F.CFA/kg	Feb.- Apr. F.CFA/kg	May - Jul. F.CFA/kg
Paddy		55 ~ 75	70 ~ 80	80 ~ 100	100
Maize		34 ~ 40	40 ~ 50	50 ~ 80	80
Cassava		25 ~ 30	40	40	25 ~ 30
Yam 1st		100	100 ~ 125	125 ~ 150	150
2nd		60	50	50 ~ 60	60
Plantain Banana		250	200	200 ~ 250	250
Peanut		50	50 ~ 80	80	50 ~ 80

Source: CIDV office, Dimbokro Department

Note: Data area as of 1992~1993

3-3-5 Supporting System

The supporting system of this area underwent a great change when the new extension supporting organization (ANADER) was established in September 1993. Before the establishment of this new organization, several agricultural development agencies, each for its corresponding crops, performed the extension supporting service and promotion of the cooperative activities. Three main agricultural development agencies, CIDV, SATMACI and SODEPRA, performed the supporting activities. Each office had two to ten extension workers in each district, with one worker covering approximately 300 farmer households (in 8 to 15 villages) for his operation activities. The new extension organization was established by consolidating the above mentioned three agricultural agencies, with CIDV covering food crops, SATMACI covering coffee and cacao and SODEPRA covering livestock. This one organization will perform all the extension activities of the main agricultural crops (except for the cotton) in this area.

ANADER has started its extension activities at the departmental office as a foothold under new policy. The disposition of ANADER staff is shown in Table 3-3-10. It may be pointed out that delay in staff dispatchment and stagnation were noted during the transition period of the organization. At present, the disposition of staff is almost satisfactory although the specialist of farmers' organization is not dispatched in M'Bahiakro and Dimbokro department. This kind of specialist is important to the project and should be depatched to the departmental office as soon as possible.

Table 3-3-10 The Disposition of ANADER staff

Speciality	Plan			Present		
	MBahiakro	Dimbokro	Bongounou	MBahiakro	Dimbokro	Bongounou
Chief	1	1	1	1	1	1
Technical Specialist	2	2	2	2	-	2
Farmer's Specialist	2	2	2	-	-	1
Supervisor	5	3	6	5	3	6
Extention worker	15	24	37	15	24	37
Secretary	1	1	1	1	1	1
Cashier	1	1	1	1	1	1
Driver	1	1	1	-	1	1
Operator (Fax & Radio)	1	1	1	1	1	1
Guard	1	1	1	0	-	1
Total	30	37	53	26	32	53

As for the agricultural credit, the Agricultural Development Bank (BND), which used to manage institutional credit for the agricultural organizations and the farmers, has terminated its operations since the second half of 1990. The termination of the Bank means that all the farmers, including those in this area, have lost access to institutional credit, and that the situation of the agricultural credit which should support the agricultural production is not very promising for the farmers.

Furthermore, as a new development, the CREP (Rural Saving Fund) and the COOPEC (Loan Cooperatives), whose activities have the characteristic of a credit union open to all the community members regardless of the occupations, have started expanding its activities throughout the country. In the survey area, one of their branches was established in Dimbokro in October 1992. At the end of September 1993, the total number of unions in all branch offices are 162, and their total capital was over 2,630,000 F. CFA. Of the 162, 79, which is about half of the members, are stockholders, and only eight, or one-tenth of them are farmers. The union has not supplied any financing yet. However, its interest rate is supposed to be compliant with the Central Bank (BCEAO). At the time of the survey, the annual interest rate was 7% for the deposit and 18% for the loan.

3-3-6 Farmers' Organization

The existing groups concerned with agriculture in the study area are classified into four types. They are cooperatives, GVC(union of GVC), informal groups and mutual aid

groups.

There is an agricultural cooperative in Dimbokro department called "Cooperative Entente". An economical farmers' group at village level is called the GVC, and a group is organized for each crop the farmers produce.

A GVC is defined as a group of people with the same profession, who live in the same village and have the same objective. In order to form a GVC, at least seven (7) members are necessary. The administration council is composed of three to eleven elected members, of which one third should be renewed every year.

In the study area, there are 191 GVCs with 9,608 members dealing with coffee and cacao production. The various GVCs have been established to bring economical benefits to farmers under the supervision of the agricultural agencies in charge. Actual activities of those groups are mostly limited to marketing of products.

Although the cooperative in Dimbokro was established in 1976 as a GVC union of coffee and cacao, it has been involved in paddy and maize marketing since 1988. From the interview of the president of the cooperative, the marketing amount of coffee and cacao has recently decreased due to the lack of capital and transportation. The collection of products is often delayed and farmers cannot get payment immediately. The number and members of GVC are shown in the following table.

Table 3-3-11 Present situation of GVCs

District	GVC.	
	No.	Members
Dimbokro	18	621
Bocanda	50	1,124
Kouassi - kouassikro	0	0
Ouelle	34	1,816
Bongouanou	47	3,284
M'Batto	28	1,811
M'Bahiakro	14	907
Total	191	9,608

Source: Annual Report of Activities 1992, Agricultural Department Office

3-4 Relevant Irrigation, Drainage, and Agricultural Projects

Currently, two projects are operated in and around the survey area: "M'Bahiakro Irrigation Project" situated just the north of M'Bahiakro City and "Adahou Irrigation Project" located two kilometers northeast of Adahou Village. Both projects, which were constructed using the funds of the Government of Côte d'Ivoire, are described below. Outlines of two other agricultural projects that are related to the survey area and still in the planning stage, and Sakassou Irrigation Project that can be referred to as a precedent are provided as well.

(1) M'Bahiakro Irrigation Project

This project has 453 hectares of cultivated area in an alluvial land that spreads over the right-side bank of the N'Zi River. The construction work of the irrigation facilities was completed by the Rice Farming Development Public Corporation (SODERIZ) in 1970. Following the dissolution of SODERIZ in 1977, the Textiles Development Public Corporation (CIDT) took over the management of the project and the proliferation of farming and education on farming techniques, which were later taken over by the Food Crops Development Public Corporation (CIDV), which is currently being reorganized into the Rural Development Public Corporation (ANADER).

The project has a total of 453 hectares of rice fields that is divided into seven blocks for separate management: Block-1 through 5, Block-5 annex, and Diaby Block. All blocks except for Block-1 are equipped with a portable pump, which discharges 70 liters of water per second with a diesel engine of approximately 15 horsepower and is used to pump water from the main stream of the N'Zi River to irrigate the rice fields.

These pumps are used only for the second season of rice cultivation (August/September to January) and put to operation upon farmers' request. If many requests are made on the same day, the operator will make up an operation schedule by the farmers' consent so that they can receive irrigation in turn. According to the farmers, the pump is operated an average of three times per hectare in the second season with each pumping operation lasting 12 hours from 6:00 a.m. to 6:00 p.m.. The cost for irrigation is estimated at 35,000 to 40,000 P. CFA per hectare for the second season only, all of which is borne by the farmers.

Since there are no drainage facilities in the area, poor drainage problems occur during the rainy season. Also, the area is subject to a flood from the N'Zi River and suffered severe damages in 1975, 1978, 1984 and 1989.

(2) Adahou Irrigation Project

This project, with planting acreage of 40 hectares, was implemented and completed by the Ministry of Agriculture and Animal Resources (MINAGRA) through the Food Crops Development Public Corporation (CIDV) as a pilot project of irrigation rice -farming set up in a valley area and spent a total of 120 million F. CFA . In the project area, an earth dam with a dike of 9.5 meters high and 400 meters long, two 1.25 km-long main canals (a total length of 2.5 kilometers), and other irrigation facilities, including a reservoir with a storage capacity of 800,000 m³, have been constructed. The construction of the dam was started in May 1991 and completed in June 1992. Irrigation canals were completed in August 1992. Of the 40-hectare planting area, 20 hectares are to be utilized for irrigation rice farming, and the other 20 hectares for non irrigated farming. Fish-breeding facilities consisted of 22 ponds, each measuring 20 meters by 20 meters, that were constructed right below the dam have not been put to use yet.

One of the characteristics of this irrigation project is that the farming is managed mainly by young people. Majority of the 34 farm households involved in the project are run by young farmers.

Following the completion of the construction, rice-growing farmers have established a GVC, which is administered by the members of the Secretariat (Chairman, Vice-Chairman, Director, Deputy-Director, Treasurer, and Deputy-Treasurer) who are elected every other year, and under which four committees outlined below are organized to handle practical affairs:

1) Management and Supervisory Committee (5 members):

Supervision of the water-level of the reservoir, maintenance and management of the reservoir, irrigation canals, and rice fields

2) Irrigation Committee (9 members):

Management of Irrigation

3) Cultivation Committee (9 members):

Management of group work and works involving machinery

4) Machinery and Material Committee (7 members):

Management of agricultural equipment (1 walk-and-push type cultivator, 1 walk-and -push type harvester, and 1 threshing machine) and joint purchase of fertilizers and other agricultural materials.

CIDV (currently ANADER), as an executing agency of the project, was laying stress on the education of settling farmers, who were experienced in growing rice in dry fields but

not in irrigated fields, by dispatching a Director in Dimbokro and other representatives in charge of the area to give guidance as well as by sending some of the farmers to the Agricultural Machinery Training Center in Grand Lahou so that they can receive technical training in handling irrigation facilities and operating and maintaining agricultural equipments.

Under the technical guidance of ANADER, members of the Agricultural Co-op's Secretariat and the Irrigation Committee hold a joint meeting to establish basic policies for water management and decide the date to start irrigation and period of rice cultivation. The Irrigation Committee members, consisting of five members in charge of right bank and four in charge of left bank, are responsible for actual irrigation activities and attend the start of irrigation. Irrigation is started on whichever the side (left or right bank) that has been chosen in advance, and the necessary amount of water is supplied to each rice field one by one from the lowest level to the top level. After irrigation of one side is over, which takes two to three days, the other side is irrigated in witness of the committee members following the same procedure. Because the area's water-retention is rather poor, irrigation has to be repeated frequently during the rice cultivating season. All cost for the maintenance and management of the irrigation facilities are borne by the farmers. According to the financial report from 1992, a uniform sum of 10,000 F. CFA was collected from each household, a total of which comes to rather a high figure or about 17,000 F. CFA per hectare.

Since the area is installed with drainage facilities of a total length of about 3.9 kilometers, including tertiary drainage canals, there have been no poor-drainage problems.

Rice cultivation was started in Adahou Irrigation District in 1992. Due to delays in facility construction, which was not finished until August, and underdeveloped farmland, the farmers were left to take over the homogenization of each rice paddy, and, as a result, the yield in 1992 was only 2.4 tons/hectare. In 1993, although they were able to raise only one crop, the average yield was 3 tons/hectare. Based on the sampling inspection, the survey team concluded that a yield of 4 to 4.5 tons/hectare could be expected in 1994. (See Table 3-3-4 for outline of cultivation, and Annex D-4 for sampling inspection.) Since the construction was completed relatively recently, the fields have not been equalized, the soils have not settled completely, and some fields do not retain water well. Also, farmers often encounter difficulties in purchasing fertilizers and other materials due to an absence of a management fund in the Agricultural Cooperative made available to the farmers. Despite such circumstances, young farmers, with enthusiasm and hard work, are quickly improving their farming techniques and yields under the guidance of farming proliferation organizations, which makes this project a good model case.

(3) Sakassou Irrigation Project

Although this project in Sakassou Province is situated far away from the survey area, its natural and social climate are quite similar to those of the survey area. Thus, in drafting the Master Plan, we referred to the Sakassou Project as a pilot case, which are outlined below:

This project was implemented as a part of the Central Region Rice Cultivation Development Project of the Government of Côte d'Ivoire receiving financial assistance from the European Development Fund (FED). The construction work had started in 1989 and completed in 1990. The size of the developed irrigation area is 400 hectares. Water is supplied from an earth dam constructed in the Loka River, one of the tributaries of the Bandama River, with a dike measuring 13 meters high and 585 meters long and a water storage capacity of eight million cubic meters, to 53 irrigated blocks through concrete main canals of a total length of 13.32 kilometers and secondary earth canals of a total length of 18.0 kilometers. Some rice paddies within the irrigated blocks receive overflowing water from other paddies. This irrigated area is equipped with main drainage canals of a total length of 6.7 kilometers. As the rice fields are created on terraces formed along the contours, their shapes or sizes are not uniform. Although rough equalization was done at the time of terrace construction, each cultivating section was left to be equalized by individual settlers.

The area, including two sections in Sakassou City, was allotted to the farmers in 13 villages, and rice cultivation was started in 1991. In 1994, the farmers decided to reorganize the Informal Group, which had been formed to manage the irrigated area in 1991, into the Agricultural Cooperative (hereinafter called Co-op), and registration procedure was in progress at the time of survey. Currently, the Co-op holds 450 members. The Co-op is administered by such officers as Chairman, Vice-Chairman, Director, Deputy-Director, and Treasurer, who are, as a rule, elected every other year. Practical business is handled by the four committees outlined below:

1) Facility Maintenance Management Committee:

Irrigation planning and maintenance/management of drainage facilities

2) Agricultural Equipment Management Committee:

Maintenance and management of 45 walk-and-push type cultivators, 20 walk-and-push type harvester, and 20 thrashers owned by Co-op and collection of usage fees.

3) Agricultural Materials Management Committee:

Collective purchasing and allotment of such agricultural materials as fertilizers and pesticides

4) Distribution and Sales Committee:

Collection, shipping, and sales of products

In addition to the above staff, 11 advisors and one clerical worker are employed.

MINAGRA has set up a system to support the farmers through CIDV (currently ANADER), a promoting organization, and assigned one chief in charge of the irrigated area and two staff in charge of agricultural promotion.

For water management, the area was divided into four irrigation blocks of upper-right block, lower-right block, upper-left block, and lower-left block of the Loka River, for each of which an irrigation plan is worked out. The whole area is further divided into 60 water-management groups, which are responsible for the execution of their respective irrigation plans. "The Central Region Rice Cultivation Development Project Management Department," which is set up in the regional office of ANADER in Bouake, drafts a basic irrigation plan, based on which the Water Management Committee of the Co-op and the chief and promotion staff of ANADER jointly work out a detailed irrigation plan for each cultivation period. As a general rule, water is supplied to each irrigation block for a duration of three to four days in rotation, which is adjusted as necessary in case of rain or water shortage. Each irrigation block selects two irrigation managers, who are in charge of the irrigation activities of the block and attend the irrigation of other blocks if needed. Water management groups that belong to their respective irrigation blocks have good working relationships as the members of these groups are relatives.

FED has provided this project with funds for the start-up and the operation of the Co-op. Under the guidance of ANADER, the Co-op has been using the funds for various purposes. First of all, the Co-op purchases fertilizers and other agricultural materials and distributes them to each farming household according to promoted cultivation standard. After harvest, each household takes 650 kilograms of harvested rice for their own consumption and hands over the rest of the unhusked rice to the Co-op, which keeps 5% of the rice to cover the running cost and sells the rest to contracted distributors. Since it takes a while to collect funds from the distributors, the Co-op pays the price of rice in advance, deducting the cost for materials and equipment usage fee defrayed by the Co-op, to each household using the money in the fund.

Prior to the implementation of Sakassou Irrigation Project, 49 farmers were engaged in small-scale "flood rice-farming" for about ten years, taking advantage of overflows of the Loka River. Although other farmers had no previous experience in irrigated rice farming, they managed to achieve an average yield of 3.8 tons/hectare in 1991, the first year following the completion of the project. The average yield has been growing steadily ever since, achieving 4.4 tons/hectare in 1992 and 4.8 tons/hectare in the first season of 1993, but it declined to 3.3 tons/hectare in the second season of 1993 due to damages caused by viral diseases. (For the outline of cultivation for 1993, see Table 3-3-4.) All the farm households are virtually growing two crops a year.

Sakassou Irrigation Project is a good illustration of close cooperation between ANADER and Agricultural Cooperative, which used the funds provided by FBD as a leverage to take strong leadership. Although it carries a characteristic of "managed agriculture," the fact that they managed to establish intensive rice farming where farmers had no experience in irrigation farming makes this project a good model to be referred to by the future projects.

(4) Things to Learn from Precedent Cases

In this section, we will exclude M'Bahiakro Irrigation Project since we have proposed rehabilitation work of this project as one of the priority development sites. Things that can be learned from Adahou and Sakassou Irrigation Project are as follows:

First, the implementation of the project has drastically improved the rice production of the areas, where farmers used to grow rice in dry fields by means of slash-and-burn agriculture. The dramatic increase in rice production has not only raised the farmers' incomes but also contributed to enhancing the self-sufficiency of the region and the country.

Second, the development of irrigation farming has completely eliminated slash-and-burn rice-farming in the relevant villages and thereby alleviated environmental destruction caused by such farming method.

Third, as irrigation rice-farming requires modern techniques and careful management, it is carried out mostly by young farmers. Thus, it has stopped the efflux of young workers and the depopulation of the villages and contributed greatly to the governmental goal of bringing back the younger generations to rural villages.

Fourth, the irrigation projects in Adahou and Sakassou proved that it was possible even for farmers who have no practical experience in irrigation rice farming to earn high

income in a short period of time by quickly mastering the techniques under the strong guidance of promotional organizations.

Fifth, as for farmers' organizations, both Adahou and Sakassou have organized farmers' associations (although each had a different name for it at the time of establishment) and set up committees and assigned staff who are in charge of water management, equipment usage, sales of products and so forth in order to facilitate their group activities. However, even farmers' associations cannot be run effectively without proper financial management. In this regard, the organization in Sakassou Project is better managed because a manager with financial expertise is positioned to take charge.

Sixth, with regards to agricultural credit, Sakassou Project is securing steady supply of agricultural materials by using their management fund to jointly purchase agricultural chemicals and fertilizers (the co-op purchases them on credit on behalf of the farmers). In Adahou area, on the other hand, farmers have no access to agricultural credit and, as a result, are significantly falling behind the Sakassou Project in terms of productivity and yields. However, in order for the co-op to purchase goods on credit on behalf of the farmers, it needs a staff with special knowledge of bank-account management, etc..

Seventh point is training and promotional activities. ANADER (formerly CIDV) is assigning promotion staff to both projects. In Sakassou district, the chief in charge of irrigated sections and two promotional staff are providing guidance in water management and related matters, which is resulting in high yield. In Adahou area, one promotional staff and the Director of the provincial office are providing support. Although not as productive as Sakassou Project, the area is expected to yield more than 3 tons/hectare. As for operation and maintenance of agricultural machinery, farmers from both projects have taken training courses conducted by ANADER (formerly CIDV), which should be continued in the future as well. However, from business standpoint, effective sales strategy is needed in addition to technical support. Comprehensive support including the assistance for technical and financial matters and distribution, which incorporates the support activities of OCPV for distribution and sales of agricultural products, will likely become increasingly important in the future.

Eighth point is the development of agricultural land. Sections at the extremities of Adahou and Sakassou sites are not connected to access roads or small drainage canals. This is hindering the ingress and egress of cultivators, materials, and products to and from the paddy fields as well as the flexible and efficient water management. Insufficient equalization of cultivation fields, especially in Adahou area, is causing uneven growth and resulting in low yield. Therefore, in forming an agricultural land development plan, these

factors need to be taken into consideration.

(5) Local Agricultural Development Project in Ouelle

This project is planned in 1993 as one of Local Agricultural Development Projects for the ex-Cacao Belt, in which the project area, Ouelle Sub-prefecture of Daoukro department is situated.

The ex-Cacao Belt, which once experienced a significant economical growth brought about by the fruitful production of cacao and coffee, has recently faced difficulties due to remarkable decline of the production of these crops and farmers' incomes derived from the unfavorable ecological and economical conditions such as scarcity of rain and lowered market prices of these products. In order to cope with the above-mentioned difficulties, Local Agricultural Development Projects for the ex-Cacao Belt have been planned being aimed at encouraging agriculture not so much depending on cacao and coffee production in this area. The following is the project outline.

The major components of the project

1) Reinforcement of the development of agriculture being currently going on in the project area

- To encourage cotton cultivation along with food crops production associated with it in 561 hectares of lands
- To develop rain-fed rice cultivation in 840 hectares of alluvial lands along the N'Zi river in the western part of the sub-prefecture and along the Comoe river in the eastern part
- To support animation and organization of food crops producers as well as marketing of their products

2) Introduction of new activities into the project area

- To encourage breeding of swine
- To introduce selected breeds of poultry
- To develop production of vegetables such as eggplant, okra and pepper in 45 hectares of lands, which will be managed by four groups of women being aimed at giving income opportunities to women

3) Improvement of infrastructure

- To construct 85.5 km rural roads for access to planned rice production areas
- To install 14 drilled wells equipped with manual pumps especially for planned

production areas

The project cost (million F. CFA)

- Investment cost	1,307
- Recurring cost	701
- Contingency cost	326
- Total	2,334 (tax-inclusive)
	2,167 (tax-free)

The funds needed for the project are to be born as follows:

Costs born by the state

- On the government budget	366 (mainly for tax payment)
- On the direct grant to the project	1,231 (seeking foreign funds)

Costs born by municipalities 16

Costs born by farmers (for recurring cost)

- On the credit system	644 (seeking foreign funds)
- On own funds	77

The responsible agency for the project is Ministry of Agriculture and Animal Resources (MINAGRA).

Regarding organization and management of the project, importance is attached to participation and cooperation of concerned local organizations and people for the successful project implementation. Accordingly, the Local Development Association, composed of people concerned in the sub-prefecture including the mayor, senior officers, village chiefs, representatives from farmers' associations is to be set up. And a executive secretary of the association is to be employed for practical business execution for the project. The Local Development Association is to send a request to the Ministry of Agriculture and Animal Resources (MINAGRA) for a feasibility study of the project.

A central steering committee is to be established, consisting of representatives from agencies concerned of the central level.

The feasibility study will be done by DCGTx through an agreement with MINAGRA in active collaboration with the Local Development Association. After approval of a draft final report of the feasibility study by the central steering committee, a final report will be submitted to MINAGRA, which is in charge of seeking funds for the project.

(6) Irrigated Rice Production Improvement Project in Central and North-central Regions

The economy of Côte d'Ivoire, which is basically depending on agriculture, especially production of cash crops such as cacao and coffee, has been disrupted by the lowered prices of these crops in the international market. As a result, encouragement of food crop production is becoming more and more important in both agricultural sector and the national economy. Among food crops, rice has become one of basic foods for recent 20 years and is increasing in demand being brought about by population growth, urbanization and the relatively declining trend of the market price. Accordingly, the government lays stress on encouraging rice production to achieve self-sufficiency of food.

As far as irrigated rice production is concerned, the Central and North-central regions have physical and human potentialities with a considerable extent of existing irrigated paddy fields. In the 5th Program of the European Development Fund (EDF), an irrigated rice production development project in the Central region was executed with a relative success. A pre-feasibility study on this project was conducted in 1993 to be proposed to be executed in the 7th Program of EDF.

The project aims at encouraging irrigated rice production through the rehabilitation, improvement and/or expansion of 25 existing irrigation schemes selected from 50 schemes in the Central and North-central regions. Although these two regions cover all of four departments concerned with the JICA's study area on the "Integrated Rural Development Project in N'Zi River Middle Basin", only Adahou and Trianikro schemes in Dimbokro department (situated outside the JICA's study area) are included in the possible EDF's project.

The following is the project outline.

The major components of the project

- 1) Rehabilitation and expansion of irrigation schemes of 2,278 hectares irrigated area
 - Rehabilitation of irrigation and drainage facilities such as dams and canals and readjustment of lots for 1,571 hectares of irrigated area
 - Expansion of 707 hectares of irrigated area through construction of canals and farm roads and preparation of lots
 - Construction of two dams for two schemes for irrigation and flood control
- 2) Construction of agricultural infrastructure and facilities
 - Rehabilitation of 325 km rural roads to improve access to irrigation areas

- Construction of 37 warehouses (120 m² or 200 m²)
- Installation of rice mills with equipment
- Preparation of fish ponds

3) Support to farmers and cooperatives

- Organization of farmers
- Provision of farm machinery
- Organization of technical extension services and provision of technical training and extension for cooperative personnel and farmers
- Setting-up a agricultural credit system for the project

Project cost and its financial sources

- Project cost (million F. CFA, as of 1993)

	tax-inclusive	tax-free
Investment cost	4,618.3	3,690.7
Operation cost	1,249.4	1,249.4
Grant to GVC for the credit system	261.8	261.8
Contingency cost	919.4	780.3
Total cost	7,048.8	5,982.2
Tax included in the above	(1,066.7)	

- Financial sources

EDF; foreign currency, local cost without tax and grant to GVC	5,982.2
Côte d'Ivoire Government; taxes	1,066.7
Beneficiaries; contribution of manpower to rehabilitation works	325.0

Schedule of project implementation

The period for the project implementation is planned to be five years.

The project is expected to be started in late 1995 or in early 1996.

Organization and management of the project

The responsible agency of the project is the Ministry of Agriculture and Animal Resources (MINAGRA). And the implementation of the project is to be entrusted to CIDV, which will be replaced with ANADER after the effective establishment of the latter.

The structure for coordination and implementation of the project contains the

following three main entities.

- A steering and monitoring committee which consists of representatives of concerned ministries and agencies. This committee has the mission of planning and budgeting for the project and will ensure the consistency of the project actions with other public interventions in the project area and with the national programs.
- A project executing unit headed by a representative from CIDV or ANADER based on the field. This unit will coordinate and supervise the support to the farmers' organization.
- The production units made up by farmers' organizations. These units will be grouped into 25 GVC governed by an administrative council, which is assisted by four committees, dealing with agricultural inputs, management of facilities, management of machinery & equipment and marketing.

3-5 Hindering Factors to Agricultural Development

In aiming at highly productive farm development in the survey area, the following factors are considered as obstacles:

(1) Physical Factors

- (a) **Inconsistent rainfall:** Judging from the precipitation pattern of the survey area, it is possible to grow rice without irrigation during the rainy season. However, because the rainfall is not necessarily consistent, a water shortage sometimes occurs even in the rainy season.
- (b) **River water shortage during dry season:** The main stream and the tributaries of the N'Zi River are the essential water source of the region. However, the flow volume becomes so little during the dry season that it is almost impossible to draw water from them under the present condition.
- (c) **Flood and poor drainage:** Although the alluvial soil in the N'Zi River basin is suitable for cultivation, its poor drainage makes the area vulnerable to frequent flooding.

(2) Social and Economic Factors

- (a) **Labor shortage:** The survey area is comprised of about 120 villages scattered throughout the region with a total population of about 30,000. The continuing

efflux of people, especially that of young workers, is causing a labor shortage among the farm households.

- (b) Damages caused by domestic and wild animals: Crops are often ravaged by such livestock as goats and sheep and such wild animals as monkeys, deers, and birds.
- (c) Lack of modern equipment: Most of the farmers in the survey area, especially those living on the hillside, are using such traditional tools as "daba" and "machette" to weed and harvest the crops. Cultivators and other agricultural machines are rarely used in the area.
- (d) Tradition of slash-and-burn farming: The staple food of the survey area consists of yam, cassava, and corn, which are grown by migratory farmers with the slash-and-burn method. However, the land can quickly lose its fertility by this traditional method unless a sufficient fallow period is given or fertilizers are fed to the land. Also, fire set by farmers is often causing the destruction of natural and man-made forests including those of coffee and cacao.
- (e) Shortage of storage facilities: Many villages are short of adequate storage facilities not only for products to be sold but also for crops for their own consumption.
- (f) Underdeveloped distribution system: Although creating a more efficient distribution system would eliminate unnecessary middlemen, enhance farmers' negotiation power, and thereby increase their profits, the existing distribution system of agricultural products in the survey area is far from being developed. Despite the fact that farmers are running such organizations as Agricultural Cooperative and Federation of Agricultural Cooperatives, they are yet to solve various problems such as lack of funds, insufficient sales promotion activities, and low collection/shipment capacities.
- (g) Underdeveloped credit system: Ever since the operation of the National Agricultural Development Bank was suspended, farmers have been cut off from financing opportunities offered by government institutions. Promotional organizations are also withdrawing from agricultural-material advancing services. Under such circumstances, farmers are facing difficulties in securing necessary materials.
- (h) Poor water-management in existing irrigation projects: The irrigation canals are

not even installed with water-gauging facilities. Poor water-management is causing an excessive use of irrigation water.

4. MASTER PLAN FOR THE INTEGRATED RURAL DEVELOPMENT

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CHAPTER 4 Master Plan For The Integrated Rural Development

4-1 General

(1) The term of the Master Plan is set from 1995 to 2015, so that its targeted termination of 2015 accords to that of "The Agricultural Development Master Plan" for the whole country formulated by the Ministry of Agriculture and Animal Resources.

The Master Plan is formulated to present a strategy on the integrated rural development in the area of 150,000 hectares of the N'Zi river middle basin. The purposes of the integrated rural development are as follows:

- (a) To contribute to the national governmental policy to promote food self-sufficiency of the country through increased production of food crops including rice,
 - (b) to upgrade income, nutritious condition and living standard of rural population,
 - (c) to encourage regional economy and to increase employment opportunities through vitalized production, processing and marketing of agricultural products, and
 - (d) to contribute to environmental conservation
- (2) The Master Plan is to be formulated taking into consideration the national policies including the above-mentioned "The Agricultural Development Master Plan", suitability of land and climate, availability of water and manpower, environmental conservation and viability from technical, economical and social viewpoints.

With regard to agricultural development in the study area, it is justified to focus on the irrigated food production, particularly irrigated rice production, rationally combined with rain-fed upland crop cultivation, considering that according to the national policy, importance is attached to increasing rice production to achieve the national food self-sufficiency, and the study area has suitable climatic conditions as well as a considerable extent of available land and water resources for irrigated rice production, and It is being explored among farmers and people concerned to introduce or to expand production of rice as a cash crop replacing cacao and coffee, whose production has recently a great deal declined.

The shifting cultivation with savanna and forest burning, which is dominantly practiced in the study area, should gradually be converted to the rotated cropping with

plowing on the well-cleared farm lands, because the shifting cultivation is inapplicable to marketable food production due to its very low productivity and likely to destroy forest environment if it is expanded as it is for increased production.

(3) With regard to basic approach for agricultural development, there are two different ways, namely a large scale development and a piling-up of small scale projects. In the study area, both the two ways are considered to be technically feasible. The large scale development is to develop the available water and land resources as much as possible in the study area through water control of the N'Zi river main stream by building a large dam on the N'Zi upper stream.

The other small scale type development is to develop resources step by step mainly through irrigated agriculture development by constructing small dams in tributaries and by utilizing the N'Zi main stream's existing discharge. Compared with the large scale type development, the small scale type development might relatively be effective and efficient for the first stage systematic development of irrigated agriculture like that in the study area because it will bear earlier return of investment (early realization of production benefit), demand lower cost and be easily financed, be more simple on the project management and make it viable to mobilize traditional village communities.

(4) Measures necessary for development should comprehensively be planned for successful implementation. This is very important for the modernized agriculture development in the study area, where the traditional shifting cultivation is still dominant and farmers are not at all familiar with modernized irrigated agriculture. Organization of farmers for water management and products marketing, supporting services for extension of advanced technology and input supply to farmers and installation of post-harvest facilities should comprehensively accompany irrigation and improved farm land development. Regarding rural infrastructure, roads are the most important and to be improved to respond transportation for increased production and communication for better living conveniences of villagers. Village water supply should also be studied to satisfy basic requirement for living of villagers.

(5) Project Outline of the Master Plan

(a) Development area

The development area is planned to be 4,613 hectares, comprised of sites supplied with water from tributary dams and sites supplied with water lifted by pumps from the N'Zi main stream. Development sites were selected based on the study

regarding their respective economical viability, soil suitability, existence of potential participants in the neighborhood and environmental aspects among technically feasible sites along tributary valleys and along the N'Zi main stream. The number of direct beneficiary farmers is estimated to be 9,300 and the number of beneficiary population including their families 58,000.

As for rain-fed agriculture, which is widely found in the Study Area, measures to improve its productivity will be planned comprehensively. Measures to encourage animal and fish breeding will also be studied.

<u>Development sites</u>	<u>Development area (ha)</u>
17 districts of tributary dams	3,685
2 districts of pump irrigation along the N'Zi main stream	953
<u>Total</u>	<u>4,638</u>

(b) Project components

Construction works

- Irrigation systems: dams in tributaries, low dams in the minor bed of the N'Zi main stream, pump stations to intake water from the N'Zi, canals
- On-farm works: 4,638 ha
- Post-harvest facilities: storehouses and rice mills
- Agricultural machinery: walking type tractors and threshers
- Rural roads: 47.9 km
- Village water supply (drilled wells with a manual pump each): 44 sites

Supporting services

- Organization of farmers
- Extension and training of farming technology and water management
- Agricultural credit

4-2 Land Use Plan

Irrigated rice cultivation combined with upland crop cultivation under rain fed condition are envisaged in this Master Plan. Following this, the concept of land use plan was setup as follows.

- (1) Proposed irrigation development areas would be determined based on the suitability of land for irrigated rice cultivation, the result of water balance calculation based on the proposed cropping pattern, and economic, social and environmental viability of the proposed sites.
- (2) For the development of N'Zi alluvial plain, the land with less flood risk should be selected. Flood protection works such as construction of flood dikes should not be undertaken because 1) the works considerably increase the project costs and 2) flood at the rate of once in five years is considered to be acceptable in agriculture.
- (3) Introduction of irrigated rice cultivation would directly and/or indirectly contribute to the effective and longer agricultural land use. Extensive agricultural land use, represented by shifting cultivation with short fallow periods, should be minimized for environmental reasons through the improvement of cropping patterns and farming practices for upland crop cultivation.
- (4) Classified forests (forêts classées) will not be subject to any type of development.
- (5) In case of irrigation development along the N'Zi tributaries, soil conservation measures should be taken in the catchment area of the proposed reservoirs in order to minimize siltation.

4-3 Irrigation & Land Development Plan

4-3-1 Irrigable Area

In this Master Plan Study, the irrigable land is defined as land suitable for paddy cultivation, since it is understood that one of the main purposes of the project is to increase rice production through irrigation development.

According to the results of soil survey mentioned in the Paragraph 3-1-1 of the Chapter 3, the lands with suitable soils for irrigation paddy cultivation is 88,700 ha (net irrigation area : 62,100 ha), of which 39,600 ha (net irrigation area : 27,700 ha) lies on the alluvial plains extending along both banks of the N'Zi river, 17,100 ha (net irrigation area : 12,000 ha) lies on the lower terrace and remaining 32,000 ha (net irrigation area : 22,400 ha) extends along the tributaries of the N'Zi river (see Fig. 3-1-2). The most area of the above-mentioned alluvial plains might suffer from occasional floods brought about by the N'Zi river main course at the rate of one in every 4 - 5 years on average mainly in September or October.

4-3-2 Methods of Irrigation Development

(1) Development of Irrigation Areas along the N'Zi River Main Course

Taking into consideration results of the study and analysis for the topographic conditions along the N'Zi river main course and available water resources, etc. For the irrigation development in the above-mentioned irrigable lands viable from technical viewpoint, the following 3 options were studied.

Option - 1: Method to use natural N'Zi river flow without construction of dams

This option intends to use the natural flow of the N'Zi river for irrigation without controlling the flow by dams. For the diversion of the river flow to crop lands, pumps or intake weirs would be required. However, gravity irrigation by using just only intake weirs would require to raise water level over 6 - 7 m, moreover as the intake points would be required to be installed over 50 - 60 km upstream from the most upstream part of the irrigation area on account of very mild river channel gradient as 1/6,500, construction of the long distance head races would also be required. Taking into consideration such conditions, pumping method at the most upstream points of each irrigation area would be optimum. Irrigation area covered by one pumping station would be suitable to be some 250 ha or less on average taking into consideration the topographic conditions, efficient water management for the future and the project execution precedent in Côte d'Ivoire. As results of water balance analysis detailed in Annex F, it is proved that this option makes possible one cycle irrigation paddy cultivation from July to November for some 4,480 ha (net irrigation area), however another cycle cultivation from December to June can not be expected because of very limited river flow in the cultivation period. This 4,480 ha irrigation farm land will be selected from the lower terrace not affected seriously by the flood damage because the alluvial plains along the N'Zi river are often subject to the flood damage of the rainy season.

Option - 2: Method to store flow water of the N'Zi river by constructing low dams in the minor bed

This option intends to cover irrigation area as much as possible for dry season by constructing low dams to store flow water in The minor bed of the N'Zi river between M'Bahiakro and Dimbokro. According to river channel profile and cross section survey made for the Study period and the topographic maps with the scale of 1/50,000, 10 low dams with some 5 m height can be constructed at the interval of 30 km on average along the length of 300 km of the N'Zi river main course between M'Bahiakro and Dimbokro. By constructing these low dams, the volume of some 50 MCM rainy season flow can be stored

constructing these low dams, the volume of some 50 MCM rainy season flow can be stored in the minor beds and two cycles paddy of some 4,950 ha (net irrigation area : 4,300 ha) can be irrigated (see Annex F). The diversion method from these low dams to the irrigation area will be by means of pumping stations with the average command capacity for 250 ha (two stations for one reservoir) like Option - 1. These irrigation area will be selected from the lower terrace not seriously affected by the flood damage.

Option - 3: Method to use N'Zi river flow with controlling the flow by constructing a large dam on the river

The N'Zi river offers a good dam site near Fetekro, about 80 km upstream from M'Bahiakro. According to the results of reconnaissance survey and examination on the topographic maps with the scale of 1/50,000, a reservoir with the storage capacity of about 1,500 MCM can easily be obtained by constructing a dam 40 m high. As results of the water balance analysis for the above-mentioned dam site taking into consideration discharge from Fetekro - Dimbokro residual basin, it is proved that two cycles paddy cultivation for 29,200 ha (net irrigation area : 25,400 ha) out of 39,700 ha irrigation suitable land lying along the N'Zi river main course is secured by constructing a dam of 38 m height with the total storage volume of about 1,142 MCM (Tentatively called as Fetekro dam) (see Annex F). Irrigation water is once released into the N'Zi river from the reservoir and taken to the irrigation lands by combination of pumping stations and fixed weir of some 2 m height respectively installed at each irrigation land. The dam reservoir can also control the flood and the flood problem to the alluvial plains along the N'Zi river would be mitigated to a great extent.

(2) Development of Irrigation Areas along the N'Zi River's Tributaries

This method intends to use the water resources endowed in the N'Zi tributaries efficiently for irrigation. Inside the Study Area some 50 large or small tributaries with the catchment area of 10 - 1,000 km² flow into the N'Zi river, however the flow is not only hardly available for dry season but also unstable even for rainy season. Therefore the construction of reservoirs is absolutely required for the development of farm lands along the tributaries. According to the results of examination on the topographic maps with the scale of 1/50,000 and the reconnaissance survey made for the Study period, 28 sites suitable for the dams construction can be found in the topography. As results of the water balance analysis for each dam site, two cycles paddy cultivation of 4,630 ha (net irrigation area : some 4,100 ha) as shown in Table 4-3-1 is made possible. Results of the water balance analysis for Dienzou, Yannon, Eholie and Atoufou river as development priority area are detailed in Annex F.

4-3-3 Irrigation Water Requirement

(1) Meteorological Data

Meteorological observations including data except rainfall observations are being made uniquely in Dimbokro-city located in the south part of the Study Area. As meteorological conditions are deemed to be almost same in the Study Area, irrigation water requirement applied for all parts of the Study Area was calculated by using these meteorological data. Daily average meteorological data for last decade (1980 - 89, as for rainfall 1973 - 92 monthly average) needed to calculate the irrigation water requirement, are shown below (see Annex F for detail).

Meteorological data at Dimbokro observational station

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall (mm)	11.5	41.1	102.0	118.5	151.2	166.3	95.2	69.6	123.3	121.9	41.9	14.7
Temperature (°C)	26.7	28.8	28.5	28.7	27.7	26.5	25.6	25.5	26.9	26.6	27.1	25.9
Humidity (%)	63	65	71	73	75	78	79	79	78	77	76	71
Wind Speed (m/s)	1.0	1.1	0.8	0.7	0.6	0.7	0.7	0.8	0.6	0.6	1.0	0.5
Sunshine (hr)	6.5	6.7	6.5	7.1	6.8	5.4	3.6	3.2	4.5	5.9	6.6	5.8

(2) Potential Evapotranspiration (ET_o)

Though some theoretical and empirical formulas are presented in order to obtain potential evapotranspiration (ET_o), Penman's formula well-known in Côte d'Ivoire is employed. The calculation results (average value of 1980 - 89) are shown below.

unit : mm												
Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
108	107	113	113	109	92	79	76	83	100	105	97	1,183

(3) Crop Water Requirement (ET_{crop})

The crop water requirement can be calculated by multiplying the potential evapotranspiration obtained in the above-mentioned (2) with crop coefficient (K_c) prepared for growing stage of each crop. The crop coefficients for each crop are to be values presented in FAO Paper 24 (see Annex F for detail).

Table 4-3-1 Factors relative to dam construction and land consolidation in the development area

Name of river	Catchment area (km2)	Factors relative to the dam					Net irrigable area (ha)	Gross area (ha)
		Volume active storage (m3)	Inactive storage (m3)	Total capacity (m3)	Dam height (m)	Crest length (m)		
Right bank of N'zi								
1. Yeboue N'zue	153	6,759,000	612,000	7,371,000	21.0	2,700.0	138	160
2. Sounglou	261	1,110,000	1,044,000	12,554,000	22.0	1,780.0	235	270
3. Toualakeua	91	4,016,000	364,000	4,380,000	24.0	1,490.0	82	95
4. Seke Goulouba	253	11,167,000	1,012,000	12,179,000	13.0	1,230.0	228	260
5. Katie	552	21,305,000	2,208,000	23,513,000	14.0	970.0	497	500
6. Mandia	107	4,702,000	428,000	5,130,000	22.0	2,040.0	96	110
7. Mo	36	2,498,000	144,000	2,642,000	11.0	330.0	51	60
8. Akpobo	21	1,420,000	84,000	1,504,000	19.0	690.0	29	35
9. Dienzou	87	2,422,000	346,000	2,768,000	14.2	720.0	78	110
10. Djanala	2	1,812,000	102,000	1,914,000	18.0	790.0	37	40
Sub-total	1,587						1,471	1,640
Left bank of N'zi								
11. Baa	967	67,337,000	3,868,000	71,205,000	24.0	1,200.0	1,383	1,590
12. Yannon	39	2,514,000	156,000	2,670,000	16.1	620.0	56	80
13. Pokouka N'zueba	26	1,812,000	104,000	1,916,000	8.0	480.0	37	40
14. Bassia	26	1,812,000	104,000	1,916,000	16.0	550.0	37	40
15. Sokpa YammieN	47	3,282,000	188,000	3,470,000	22.0	720.0	67	75
16. Abode	48	3,379,000	192,000	3,571,000	8.0	1,430.0	69	80
17. N'bliazueba	25	1,763,000	100,000	1,863,000	13.0	350.0	36	40
18. Baya	24	8,326,000	2,095,000	10,422,000	14.0	600.0	170	200
19. Baa	26	1,469,000	104,000	1,573,000	16.0	560.0	37	35
20. N'zimineu	97	2,988,000	388,000	3,376,000	9.0	550.0	139	70
21. Eholie	65	4,620,000	260,000	4,880,000	16.0	965.0	91	130
22. Boudasse	73	5,094,000	292,000	5,386,000	19.0	450.0	104	120
23. N'diti	11	784,000	44,000	828,000	6.0	330.0	16	20
24. Kpokpla	23	1,616,000	92,000	1,708,000	18.0	570.0	33	40
25. Atofou	110	8,460,000	440,000	8,900,000	17.3	910.0	165	200
26. Damin	97	6,808,000	388,000	7,196,000	19.0	830.0	139	160
27. Songan	30	2,106,000	120,000	2,226,000	18.0	630.0	43	50
28. Ebimolo	14	980,000	56,000	1,036,000	11.0	480.0	20	25
Sub-total	2,248						2,642	2,995
Grand total	3,835						4,113	4,635

(4) Percolation

As results of the field survey at Adahou and M'Bahiakro scheme, the percolation through the paddy field is estimated at 5 mm/day for loam and 10 mm/day for sandy soil.

(5) Puddling Water Requirement

The puddling water requirement needed before sowing paddy is to be 150 mm. The puddling period is planned to be 30 days in total by dividing the puddling period in 3 stages with 10 days each.

(6) Effective Rainfall

The effective rainfall is obtained for both paddy and upland crops on the basis of 20 year rainfall data of 1973 - 92 as shown below.

Paddy

- daily rainfall < 5 mm effective rainfall = 0 mm
- $5 \text{ mm} \leq \text{daily rainfall} \leq 80 \text{ mm}$ effective rainfall = daily rainfall \times 0.8
- daily rainfall > 80 mm effective rainfall = $80 \text{ mm} \times 0.8 = 64 \text{ mm}$

Upland Crops

- daily rainfall < 5 mm effective rainfall = 0 mm
- $5 \text{ mm} \leq \text{daily rainfall} \leq 65 \text{ mm}$ effective rainfall = daily rainfall \times 0.8
- daily rainfall > 65 mm effective rainfall = $65 \text{ mm} \times 0.8 = 52 \text{ mm}$

Notice : TRAM (Total Readily Available Moisture) is assumed to be 65 mm.

(7) Cropping Pattern

The proposed cropping pattern to estimate the irrigation water requirement is as shown in Fig. 4-3-1.

(8) Irrigation Efficiency

The irrigation efficiency for paddy field and upland is set up as below.

Efficiency	Paddy Field	Upland
Application	90 %	90 %
Conveyance	72 %	72 %
- Main Canal	(90 %)	(90 %)
- Field Canal	(80 %)	(80 %)
Irrig. Efficiency	65 %	65 %