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THE ECONOMICS OF TILAPIA CULTIVATION IN KASAI OCCIDENTAL, ZAIRE

A Study

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by

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Abstract

The purpose of this study was to assess the socioeconomic impact of the adoption of fish pond culture on family well-being in Kasai Occidental, Zaire. The three research areas chosen (Luiza, Dibaya, Kananga) had previously been exposed to tilapia culture during colonial times, and were the initial sites selected in this region by Projet Pisciculture Familiale which was designed to introduce intensified feeding techniques using a new species, Oreochromis niloticus.

An assessment of the project's overall effect was made by conducting interviews between October 1983 and February 1984 in each of the original locations where the extension service had operated for at least four years. In total, 153 farmers were interviewed, of which 46 were initial "model" adopters still raising fish; 44 were secondary adopters, of which 54% had never had any contact with the extension service; 26 were individuals who had abandoned their ponds; and 37 were non-participants. This information was supplemented by direct observations of pond-related activities, surveys of market prices, and statistics from government sources and local businesses.

Five factors emerged as being the most important criteria for ensuring long-term sustainablity of rural pond operations:

1) the building of ponds that can withstand heavy rainfall in well-selected sites,

2) self-sufficiency in fingerling supply,

3) stable, good health of the principal fish farmer,

4) the lack of excessive theft, and

5) the existence of an adequate labor supply for feeding fish.

In the urban study area, the availability of inexpensive supplementary feeds was more critical than having numerous household members involved in the feeding process. Pilfering was the second most serious constraint faced by farmers, the first being that of obtaining sufficient amounts of feed.

While favorable prices for fresh tilapia encouraged the adoption of intensive techniques, they did not guarantee their continued practice. In rural areas, the availability of labor for feeding activities ultimately determined whether the ponds were extensively or intensively managed. Farmers in both the rural and urban sectors derived considerable benefit from harvesting fish for home consumption. In many instances the value of this contribution outweighed cash sales.

Tilapia culture is a labor-intensive operation that provides a high gross return per unit of land in both the urban and rural areas. Labor requirements for pond construction, feeding, maintenance, and harvesting were estimated based on survey data. The division of labor by gender and age for different pond activities varied between areas. Non-labor inputs and costs were estimated for pond construction and for maintenance. The profitability of fish culture relative to other activities was calculated for a small sample of pond operators who kept reasonably complete records. Successful pond operators sought to maximize total production of tilapia through expanding the area in production rather than output per unit of land.

Among the recommendations based on the study are that more consideration be given to a strategy of one partial harvest and one complete harvest annually in lieu of complete harvesting every 6 months. Smoking tilapia was also found to be an economically feasible marketing

strategy for larger producers in the urban area. Because women often played a crucial role in feeding as well as construction and harvesting, the extension program should redirect a larger proportion of seminar training sessions and extension visits to include adult women. Although the possibilities for organizing viable animal-fish systems appear limited, the prospects for integrating fish culture extension with crop improvements are brighter.

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I. INTRODUCTION

During the past two decades, there has been a substantial growth in the number and variety of aquaculture projects in developing nations. Research has focused on overcoming the biological and technical problems inherent in various types of maritime and inland systems. By comparison, there is a relative dearth of reliable information available on the economics of new production systems or their sociocultural impact, particularly for projects undertaken in Sub-Saharan Africa. Those studies which have been done on programs aimed at improving the livelihood of the rural population have pointed to the general failure of large-scale, vertically-integrated enterprises that demand a great deal of capitalization, managerial expertise and technological sophistication (McGoodwin, p. 64). These analyses have helped promote the idea that what is needed are more "appropriate" technologies which do not require large initial capital inputs. To date, few of these types of programs have been developed in aquaculture, so it is not surprising that assessments of their "success" are rarely found in the literature.

Projet Pisciculture Familiale is a small-scale fish culture project in Zaire designed to encourage the intensified feeding of tilapia (*Oreochromis niloticus*) in earthen ponds. Aimed at improving the well-being of subsistence level households, its design stands in stark contrast to the highly sophisticated approaches mentioned above. The examination of Projet Pisciculture Familiale (P.P.F.) provides an opportunity to explore the levels of sustained acceptance

that can be achieved by subsistence farmers who must rely on locally available inputs while facing severe economic constraints.

The idea for launching a program for cultivating fish in ponds had its antecedents during the colonial period. Pond culture in Zaire was extensively promoted by the Belgians during the 1940s and 1950s, but was virtually abandoned during the turmoil following independence in 1960. The current project grew out of a joint pilot program initiated by Peace Corps and OXFAM in 1975 to reintroduce tilapia culture in the Bandundu Region using improved management techniques with Peace Corps volunteers serving as extension agents. Expanding upon the colonial approach, the purpose of this effort was not only to promote the raising of fish as a means of increasing available protein to the family, but to enhance family income through the sale of surplus production.

The expansion of fish culture into the region of Kasai Occidental began on a pilot basis in 1977 with the placement of two extension agents in the Zones of Luiza and Tshikapa. By the following year, the initial successes seen in the Bandundu area led to the involvement of the United States Agency for International Development (U.S.A.I.D.) and the Government of Zaire (G.O.Z.) under the auspices of Projet Pisciculture Familiale.[1] Their joint efforts led, in 1979, to expanding the area covered to include three additional posts in the Zones of Luiza, Dibaya and in the urban center of Kananga. While the

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[1]The total commitment of the three agencies (Peace Corps, U.S.A.I.D., G.O.Z.) over the six year life of the project (1978-1983) was $5,043,000. Of this, the U.S.A.I.D. contribution to the project (Number 660-0080) was $900,000.

diamond-rich Tshikapa Zone was subsequently abandoned due to lack of farmer interest and logistical problems, elsewhere the project met with widespread acceptance. In 1981-82 three additional rural Zones were incorporated into the program (Kazumba, Demba, Mweka). By mid-1983, sixteen volunteers were in the field (see Map 1), a regional office with a staff of four Zairians had been established, and a fingerling/demonstration center had been constructed on the outskirts of the city.

The purpose of this research was to assess the impact of pond culture on family well-being particularly in regard to its relative importance as a tool for income generation compared to other agricultural and non-agricultural activities. Field work was undertaken between October 1983 and February 1984 in the three original locations in Kasai Occidental where the extension program was initiated.[2] Interviews with both project and non-project fish farmers and direct observational surveys constituted the primary data gathered to meet the principal objectives of the study.

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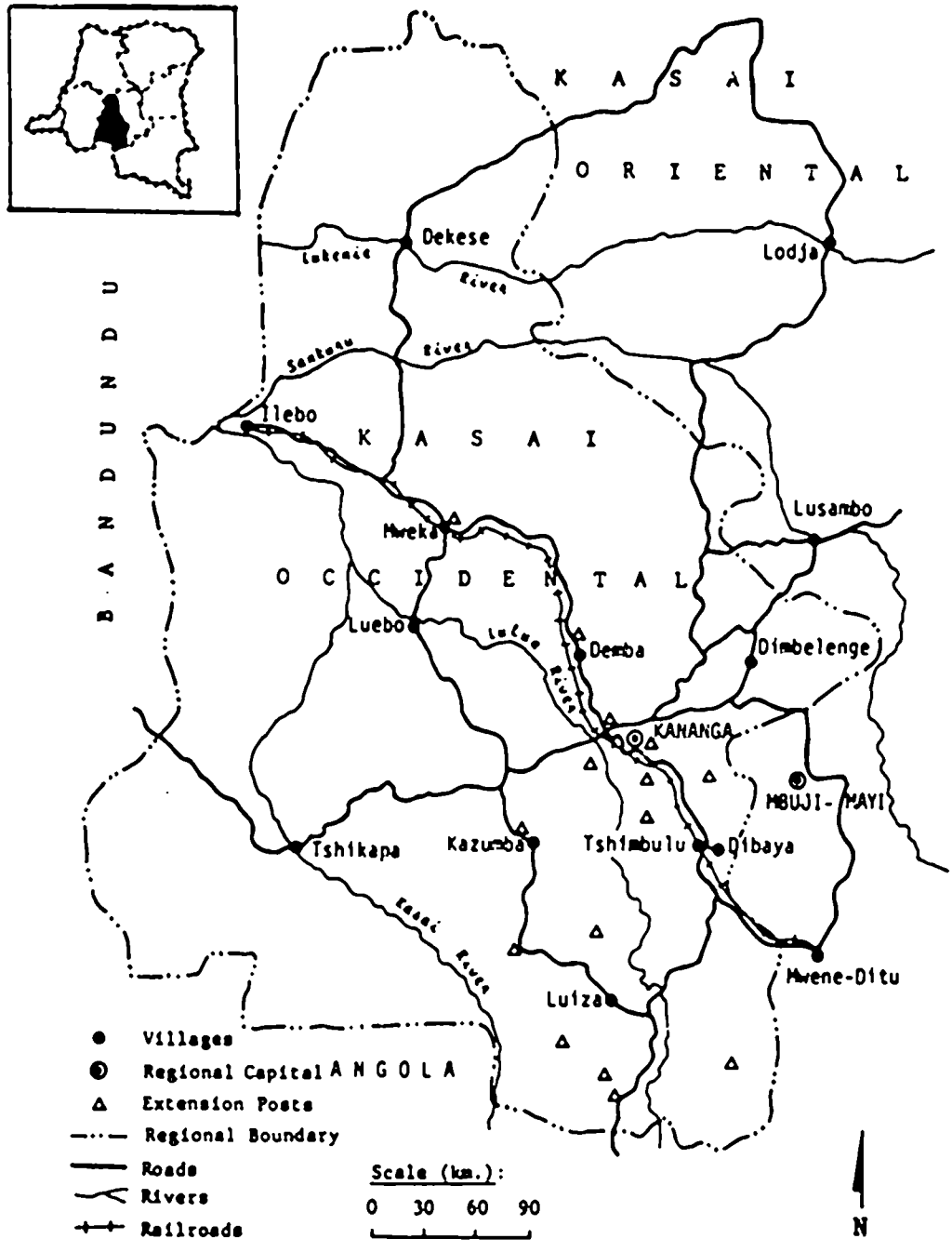
[2]Ideally, a study of this kind should include the original zone in which the project began, Bandundu. However, due to the limited time available, the area chosen was the one in which the author could put her personal abilities to best use, namely knowledge of the local language and familiarity with the growth of the program in that region. Moreover, it would be difficult to locate many of the initial adopters in Bandundu due to the length of time that has elapsed since the program was initiated in that area. As of mid 1983, Projet Pisciculture Familiale operated in the two Kasais (Kasai Occidental and neighboring Kasai Oriental), Bandundu, and Bas-Zaire. The Peace Corps also was conducting a pilot program in the Kivu Region.

MAP 1. EXTENSION POSTS IN KASAI OCCIDENTAL, 1983



These objectives were as follows:

1) To assess the overall socioeconomic impact that the adoption of fish pond culture has made on household income levels and labor allocation in the three areas in which P.P.F. began to operate in Kasai Occidental.

2) To compare the market value of fresh tilapia to other common protein and carbohydrate sources in the region.

3) To examine how variations in management skills among farmers and seasonal changes of labor demand for other activities affect yields of pond-produced tilapia.

In assessing the impact of the project, account must be taken of the dominating nature of the deteriorating economic condition in the country itself. "Despite a wealth of natural resources, Zaire suffers from gross scarcity of goods of all kinds, including food and fuel; declining industrial and agricultural production; a drastic deterioration of public health, education and economic infrastructure; a rate of inflation of nearly 100 per cent; and a national foreign debt of $4 billion" (MacGaffey, p. 353). The institutionalized bureaucratic corruption which has led to a massive rural exodus and the collapse of the productive infrastructure is documented in works by Gould (1980) and Gran (1979). Even when farmers do cultivate, they are faced with producer prices that have failed to keep pace with rising costs. Moreover, sale of their crop may be delayed due to impassable roads.[3] Farmers are forced to operate at a subsistence level unless a way can be found to transport his/her produce to a major center.

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[3]Most road workers are paid on an irregular basis, if at all. As a result, only 24,000 km of the 145,000 km of roads that once existed throughout the country are utilizable (Gould, p. 110).

The struggle for survival in Kasai Occidental has intensified since the project's inception in 1977. Families have had to contend with the persistent decline in the purchasing power of what they earned. Numerous devaluations of the currency have taken place since 1976.[4] The value of one Zaire in U.S. dollars fell from 34 cents in early 1980 to 3 cents by the end of 1983. The latest devaluation in September 1983 was particularly severe in that it hit the urban poor extremely hard, unlike previous ones which had primarily affected the better-off sectors which could afford to purchase imported goods. Staple food prices skyrocketed in response to the quadrupling of diesel prices for lorries bringing in commodities from the countryside (Q.E.R. (1983b), p. 7). The general price index in Kananga alone reached 3302 by September of 1983 from a base value of 100 in 1976 (I.N.S. (1983)).

Consequently, able members of the household frequently traveled considerable distances in order to engage in small-scale trading or to dig in the diamond areas. Gould (p. 109) cites a 1975 report of the Department du Developpement Rural which stated that although 65-70% of the country's population was living in the rural areas,

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[4]From June 24, 1967, through March 11, 1976, one Zaire (Z) equaled U.S.$2. On that date the effective value of the Zaire became $1.15. The Zaire underwent a 50% devaluation in 4 stages between November 1, 1978, and January 2, 1979. On February 22, 1980, Z1 equaled 34 cents (World Bank (1979)). The decline continued. By June 1981 one Zaire was worth 18 cents. A dramatic devaluation occurred on September 10, 1983, with the value of Z1 plummetting from 17 to 3.6 cents. The intent of the last devaluation was to bring independent sellers of foreign exchange into the commercial banks. The new exchange rate of Z29.9 equal to $1.00 was close to the black market rate which had been Z30 to Z35 to the dollar. The exchange rate was to be periodically readjusted to keep pace with any parallel market that might develop. As of May 23, 1984, Z35.69 equaled $1.00.

only one tenth of the total was actively involved in the agricultural sector. This means that one rural farmer was feeding three urban dwellers plus seven rural inhabitants. The situation is most likely to have deteriorated since then, although in several instances young men were encountered in the villages who had returned to cultivate land after having failed in their endeavors elsewhere.

The three locations included in the assessment survey exhibit distinctly different agricultural conditions which may have influenced to a great extent the local ability of residents to adjust to the ever increasing difficulties. Cash resources were found to be limited in both the rural and urban sectors, but at least the former had access to a subsistence agricultural system. In the Kasais, food crops have become cash crop equivalents for those with market access. The economic chaos which prevailed in the early 1980s also encouraged the ready adoption of pond culture as the availability of tilapia reduced the family's vulnerability to risk by providing fish for home consumption as well as a source of immediate cash.

While considering the economic conditions and agricultural endowments in each area, the ultimate question to be addressed is whether, in the long-run, the farmers themselves believe that the benefits of pond culture warrant the labor input demanded by intensive cultivation techniques. This, in turn, raises the issue of whether or not the marginal productivity of labor for non-pond related activities in these areas is near zero. If it is not, then the amount produced by farmers engaged in pond culture must be weighed against the loss of output from other endeavors.

II. OVERVIEW

A. A Brief History of Fish Pond Culture in Zaire

The Belgian Congo was among the first of the African colonies to undertake a massive program of tilapia production. The first attempt at tilapia cultivation took place in 1937. Previous to this, only Kenya (in 1924) and Egypt (in 1934) had experimented with "modern" tilapia culture (Balarin and Hatton, p. 137). The efforts of the Belgian colonial government were focused on what they perceived to be a growing "protein deficit" among the population. To alleviate this problem they hoped to develop the country's immense river and lacustrine fisheries potential and to establish fish ponds in every province.

This interest is reflected in the goals set for warm water fish production in the Congo's Premier Plan Decennal published in 1949. Its objectives called for a 10,000 ton increase in the output of fish from rivers and lakes during the following ten years, up from an estimated 30,000 tons in 1949. In addition, because of the excellent yields that had been obtained at an experiment station established in Elizabethville[1] several years earlier, the government embarked on an ambitious project calling for the construction of 75,000 hectares[2] of ponds, which would produce an estimated 60,000 tons of fish per year by 1959 based on predicted

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[1]Elizabethville has been renamed Lubumbashi, and is the regional capital of the Shaba region.

[2]1 hectare = 2.47 acres = 100 ares; 1 are = 100 square meters.

average yields of 800 kg/ha/year. (Gomez, et al., p. 690). The program initially concentrated on building large stations having total surface areas ranging from one to several hectares in size, as well as encouraging individuals to build ponds. In many instances, African farmers who refused to cooperate were taxed.

By the mid-1950s, the initial euphoria towards pond culture as the answer to malnutrition in the Congo had diminished considerably. A conference was held at Yangambi in 1957 at which officials from the Services Pêche et Pisciculture de l'Administration[3] and researchers from INEAC[4] reassessed their approach to pond culture. The original planners had underestimated the immensity of the cost involved in the establishment and supervision of 75,000 hectares of ponds. The initial yields obtained at Elizabethville on which program projections were based had been the result of excellent site selection, intensive feeding, and good maintenance. While the new fingerling centers were achieving average to excellent yields[5], the rapid dissemination of the technology among villagers led to the

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[3]Fisheries and Fish Culture Administrative Service.

[4]Institute National pour L'Etude Agronomique Du Congo Belge (National Institute for Agronomic Studies in the Belgian Congo).

[5]For example, average yield figures available for five principal stations from 1958 to 1959 were as follows:

Muanzi (Leopoldville Province)	1,518 kg/ha/yr
Kianza (Leopoldville Province)	860 kg/ha/yr
Gene Gene (Orientale Province)	7,500 kg/ha/yr
Mabenga (Katanga Province)	2,157 kg/ha/yr
Gandajika (Kasai Province)	1,840 kg/ha/yr

(Gomez et al., p. 707)

stocking of ponds of all shapes and conditions, which were often no more than small holes in the ground.

Moreover, the high cost of obtaining good yields at the stations caused the Yangambi conference participants to shift the emphasis of their program towards smaller-scale operations. As stated by Capart and Kufferath (p. 1246): "The original concept has altered from a big production pond, costly to construct and difficult to harvest, to the notion of small individual ponds, with a reduced surface area, less costly, and realizable at the individual or family level."[6] Officials were also beginning to appreciate the important role that extension education would have to play if small farmer fish production was to be successful. As a result of this reevaluation, all new expansion efforts ceased in 1957 in an effort to concentrate on improving the ponds which already existed, with particular emphasis on increasing production through improved feeding.

By the end of 1958, some 122,404 ponds had been built in the Belgian Congo (Bulletin Agricole, p. 1093). The total surface area of 4,084 hectares fell far short of the original goal of 75,000, but was far ahead of any other African nation at that time. However, the Belgians were not able to test their new approach due to the civil turmoil which racked the country after independence in 1960. Furthermore, very little of that initial effort was left by the late 1960s as both stations and small holder ponds were neglected or abandoned.

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[6]Author's translation from the French

B. Growth of Pond Culture in the Lulua District

Kasai Occidental covers 156,967 square kilometers. The Region is divided into the three Sub-Regions of Kananga, Lulua, and Kasai. The two rural research areas in this survey are located in the Sub-Region of Lulua, which consists primarily of savanna interspersed with forested valleys. A fifth of the Region's estimated 2.4 million population is concentrated in the urban Sub-Region of Kananga.

During colonial times, the land area making up Kasai Occidental and Kasai Oriental was combined into one Province known as the Kasai. The Kasai, in turn, was divided into four Districts: the Lulua, the Kasai, the Sankuru, and Kabinda. The Districts were further sub-divided into Territories which, though now referred to as Zones, have retained the same boundaries.

The Belgians made a significant effort to involve Congolese in raising tilapia in Kasai Province. Just two years after the Ten Year Plan was released, officials claimed that around 1,400 "indigenous cultivators" in Kasai had their own ponds. The total area occupied by these ponds was 21 hectares, which averages out to 1.05 ares per farmer. In contrast, the remaining 254 hectares were held by 274 "European cultivators", the mean in this case being approximately ninety-two times the size of that for the local villager (Bulletin Agricole (1951), p. 777).

The rapid growth of the total surface area under production in the Kasai Province can be seen in Table 1. By the end of 1955, some 3,401 ponds in the Lulua District were counted as belonging

TABLE 1. DEVELOPMENT OF FISH CULTURE IN THE KASAI PROVINCE*

	1949		1950		1951		1952		1953		1954		1955	
	Number of Ponds	Surface Area (ha.)	Number of Ponds	Surface Area (ha.)	Number of Ponds	Surface Area (ha.)	Number of Ponds	Surface Area (ha.)	Number of Ponds	Surface Area (ha.)	Number of Ponds	Surface Area (ha.)	Number of Ponds	Surface Area (ha.)
KASAI DISTRICT:														
Government-owned	4	.45	12	19.00	24	21.48	36	24.53	33	9.27	29	9.27	5	1.70
Missions	1	.03	74	15.88	75	16.63	77	15.38	63	17.01	63	17.01		
Private Companies	7	8.40	7	8.40	14	8.04	14	8.04	18	5.80	18	5.80		
Colonialists	4	2.00	4	2.00	0	0	0	0	0	0	0	0		
African Farmers	0	0	532	12.15	522	10.00	800	15.50	423	8.43	723	35.43	6	0.60
SUBTOTAL	16	10.88	629	57.43	635	56.15	927	63.45	537	55.01	833	67.51	11	2.30
LULUA DISTRICT[a]:														
Government-owned													117	26.05
Missions													82	30.15
Private Companies													9	0.59
Colonialists													1	3.00
African Farmers													3,401	113.47
SUBTOTAL													3,610	173.26
TOTAL FOR PROVINCE:														
Government-owned	28	7.34	62	40.66	117	161.85	198	225.98	209	203.23	192	210.61	219	192.42
Missions	46	5.21	202	40.38	201	41.28	211	41.83	183	45.26	186	124.16	171	40.92
Private Companies	14	11.06	18	27.70	40	36.04	45	24.28	57	36.04	70	45.59	29	12.81
Colonialists	8	4.00	9	4.03	7	4.00	7	4.00	7	4.00	0	0	5	4.85
African Farmers	0	0	1,349	19.38	1,739	35.23	2,315	44.58	2,780	43.19	9,127	124.16	14,922	182.94
TOTAL	96	27.61	1,640	132.15	2,104	278.40	2,776	340.67	3,236	331.72	9,575	426.07	15,346	433.94

a/ The Lulua District was an administrative division created on January 1, 1955. Before then it was a part of the Kasai District. As can be seen from the 1955 figures, most of the pond construction up until that time was done in the area making up the Lulua District.

*Adapted from H. Renson, Extraits des Rapport Annuels (mimeograph, Luluabourg), April 21, 1956.

to Congolese farmers. No information was found on the average number of ponds per farmer, so even if one made the unlikely assumption that each pond belonged to a different individual, then the maximum possible number of pond-owning farmers would be around 3,400 for the Lulua District. However, such recorded pond estimates should be viewed sceptically: the Director of the agricultural service in the Kasai Province admitted to his superiors in a letter dated May 1956 that the statistics gathered in Dibaya Territory were deceiving-- "many of the individual ponds are very small, without yields and frequently abandoned" (Pattyn, p. 2). In a subsequent report which dealt with the question of why some farmers were abandoning their ponds, the provincial fish culture advisor concluded as follows: "It is more worthwhile to have a few hundred ponds giving interesting outputs for a few producers than having thousands of which their sole importance is to be figured into statistical reports" (Renson, p. 5).[7] This was the practical reality in the field that formed the backdrop to the conference held at Yangambi the following year.

One of the outgrowths of that meeting was the decision to undertake a massive country-wide survey of local animal protein production to help establish areas of priority for developing fisheries and/or pond culture. A distinction was made between "natural production" (gathering insects,[8] hunting and fishing)

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[7]Author's translation from the French.

[8]The edible insect category includes caterpillars and various other forms of larvae. The report provided no information as to how insect consumption was actually measured.

and forms of husbandry such as raising fish, cattle, goats, chickens, etc. The survey assessed each of the 102 Territories making up the Belgian Congo during 1957-1958 to see what percentage of the population's animal protein needs in each Territory were being met by local production. While the manner in which the theoretic protein need of the population was derived is now outmoded,[9] the estimated values do provide a comparison of the relative importance of various animal protein sources available throughout the Belgian Congo. Of all the Provinces, Leopoldville (which included the area now known as Bandundu) and the Kasai were the least able to meet their population's needs with local production.

As can be seen in Table 2, insects and river fish were the predominant source of animal protein in the Lulua District. The annual output from fish ponds for the entire area was estimated to be 3,540 kilograms, a third of that being produced in the urban center of Luluabourg (now Kananga). The latter was the only Territory within the District in which fish pond production made up at least 1% of the local animal protein production. The overall fish production figures for Dibaya and Luiza were only 560 and 441 kilograms, respectively.

In the post-independence period, urban centers began to mushroom in size. Kananga's population, for example, increased an estimated

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[9]It was assumed that every adult male and female needed 20 gms. of <u>animal</u> protein daily, each child 10 gms.

TABLE 2. SURVEY ON ANIMAL PROTEIN PRODUCTION: LULUA DISTRICT, KASAI PROVINCE

Territory	Surface Area	Population: Adults (A) Children (C) Total (T)		Population: Total per Km^2	Local Animal Production: Insects	Hunting	Fishing	Pond Culture	Live-stock	Poultry	Total
	(Km^2)				(kilograms)						
Luluabourg	2,942	A C T	71,408 59,869 131,277	44.6	38,895	2,348	70,782	1,208	10,195	4,924	128,352
Dibaya	10,728	A C T	86,798 69,225 156,023	14.5	76,400	48,000	155,600	560	31,088	6,200	317,848
Luiza	14,702	A C T	83,081 51,212 134,293	9.1	108,389	49,000	173,938	441	12,315	5,659	349,742
Kazumba	10,900	A C T	68,185 68,974 137,159	12.5	142,246	5,616	204,011	1,311	9,111	6,116	368,411
Demba	8,825	A C T	51,263 42,432 93,695	10.6	60,330	48,374	31,740	20	3,085	17,320	160,869
TOTAL FOR DISTRICT:	48,097	A C T	360,735 291,712 652,447	13.5	426,260	153,338	636,071	3,540	65,794	40,219	1,325,222

Adapted from Gomez, et al., "Production de Proteines Animales au Congo," in Bulletin Agricole du Congo, Vol. 52, No. 4 (Brussels, 1961).

118% between 1956 and 1974 (I.N.S., p. 28)[10]. The availability of locally captured river fish and wild game declined as the population density rose in both the urban and rural areas. Insects have continued to play a major role in the diet. Urban residents, in particular, have become increasingly dependent on dried fish from other regions and rely mainly on vegetative sources of protein such as manioc leaves. In 1968, the Catholic diocese introduced soya production in the Zones immediately surrounding Kananga in an attempt to overcome protein deficiency. Fish culture, however, existed only on a minor scale in localized pockets until Projet Pisciculture Familiale re-initiated the activity in Kasai Occidental in 1977.

The degree of previous exposure to some sort of pond culture would most likely affect any new extension program in several ways. One might expect in areas where harvests were viewed as successful, the rate of adoption of pond culture would be faster than in those places where no ponds had been constructed. Likewise, any previous failures in a particular location could lead to great reluctance on the part of local farmers to risk participating in the venture.

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[10]Many reports (such as one prepared by American University, p. 283) quote the official government statistic of 1970 which set the population of Kananga at 430,195 based on a general census. This would imply a 224% increase in population between 1959 and 1970. A survey conducted by the Institute National des Statistiques in 1974 set the population level at 253,410 and rejected the earlier figure as being far too high. Nzongola-Ntalaja (1975) counters the I.N.S. conclusion and claims that the 1970 census data were considered overestimates because critics were using the 1958 colonial census as their point of departure. He stipulates that the figures for the latter were severely underestimated as illegal residents would temporarily move out of the quarter being surveyed in order to avoid the census takers. No additional survey data have been published since 1974, so the issue is likely to remain unresolved.

From the technical standpoint, the renovation of old ponds can be a mixed blessing. On the one hand, the farmer would know whether or not the site was viable based on previous experience. On the other hand, unless substantial rebuilding is done, old ponds tend to leak or break when filled.

Each of the areas under consideration in this survey had some previous exposure to pond fish culture. It was obvious that demand for any fish to be marketed would be high. The desire to participate, it was assumed, would be influenced by whether the farmer had been forced to construct a pond previously, or had retained a relatively positive opinion of the colonialists themselves.

C. Implementation of Projet Pisciculture Familiale

The implementation of the project in Kasai Occidental was patterned along the same lines as the successful pilot program undertaken in Bandundu. The overall design itself was an outgrowth of lessons learned from the Belgian effort together with experience gathered from Peace Corps fisheries programs in other African countries, including Cameroun, the Central African Republic, and Togo. The main improvements over the colonial system were the selection of a more productive species and the introduction of improved management techniques through regular visits by extension agents. Principal features of pond construction and management approaches used in the project are based on those described by Torrans (1973) and Chakroff (1976).

The Selection of *Oreochromis niloticus*[11]

The qualities of Tilapia in general--their ability to reproduce in small bodies of water, to withstand low oxygen levels, and to resist disease--made early researchers refer to it as the "miracle fish." *Oreochromis niloticus* is one of the eight Tilapia species reviewed by Shoenen (1982) as being of current importance in aquaculture. Whereas the Belgians had built their program around the use of *Tilapia melanopleura*[12] and *Oreochromis macrochir*, *O. niloticus* is a versatile microphagous feeder superior to the former on several counts. It has the ability to utilize plancton (unlike *T. melanopleura*), as well as leaves and various by-products. It also matures sexually four to five months earlier than does *O. macrochir* (Balarin and Hatton, p. 128).

Experience had revealed that tilapia species could tolerate low levels of oxygen for substantial periods of time; consequently, the colonial practice of running water through ponds in order to ensure an adequate oxygen supply was abandoned. In doing so the

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[11]The taxonomic classification of Tilapias has undergone much change during the past twenty years. *Oreochromis niloticus* is often referred to as *Tilapia nilotica* in the literature. The genus *Tilapia* was differentiated into two distinct genera by Trewavas (1973), namely: *Sarotherodon*, the mouth brooders, and *Tilapia*, the substrate spawners. Recently, the *Sarotherodon* group has been further subdivided into three mouthbrooding genera (*Oreochromis*, *Sarotherodon*, and *Danakilia*). *Oreochromis* includes all species which are *maternal* mouth brooders (Trewavas (1982)). The common name tilapia will be used to refer to all categories in general, and implies *O. niloticus* when discussing those fish distributed by P.P.F.

[12]*Tilapia melanopleura* as it appears in the literature today would be classified as *T. rendalli*, *T. zillii*, or a mixture of the two (Pullin, p. 65).

natural food found in the pond was retained instead of being periodically flushed out. Furthermore, the nutrient content of the pond is enhanced through composting with organic waste material to encourage plancton growth. O. niloticus is omnivorous but mainly feeds on phytoplankton. It can also utilize blue-green algae, benthic fauna, leaves, and agricultural by-products (Balarin and Hatton, p. 129).

In terms of farmer self-sufficiency in fish production, the greatest advantage tilapia species in general have over other cultivated fish such as carp is their prolific reproductive capacity. In principle, fingerling centers should become redundant over time since farmers having an initial stock should be able to restock without having to return to the station.[13] For example, a mature O. niloticus female produces 1500 to 2000 eggs at a time, spawning at least three times a year (Balarin and Hatton, p. 129). In many African and Asian countries, tilapia culture is not popular because of this so-called "excessive" reproduction which results in harvests in which over 50% of the fish are too small to be marketed. This is not the case in Zaire, where all sizes of fish

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[13]One of the major pitfalls encountered in the Peace Corps fisheries program in Cameroun was the introduction of carp among farmers who were already cultivating tilapia. Pituitary gland injections were required in order to induce the carp to spawn. This necessitated dependence on a fingerling center for each restocking. The government stations were subsequently unable to keep pace with the demand for carp fingerlings. Farmers were reluctant, however, to return to just raising tilapia once they had been exposed to the larger carp. As a result many farmers lost interest and dropped out.

are eaten and in some instances, smaller fish have even been known to sell for a higher price per kilogram.

Tilapia fingerlings are usually stocked when they are approximately two months old (8 to 12 grams). O. niloticus is mature two to three months later. If an intensive feeding strategy is followed, the pond should be harvested after six months as the growth rate will have peaked by this time. This is a vast improvement over the slower maturing species employed in Belgian times when harvesting was usually done on a yearly basis.

While O. niloticus is being recognized as one of the best performers under tropical conditions among the tilapias, one cautionary note should be made in regards to the stock employed in the Zairian program. As in many developing countries, it is likely that the stock used in the current project has become contaminated through contact with other wild species. In addition, as all O. niloticus fingerlings distributed by agents in Kasai Occidental are descendants of approximately 100 fingerlings flown into Luiza from the Bandundu region in 1977, there is the long-term possibility that the species will become highly inbred.

Selection of the Target Group

The project was primarily aimed at providing rural male farmers with an activity that complemented crop production. Each extension agent was expected to cover a radial area of up to 40 kilometers from his/her home base. The operational philosophy focused on locating and training a core group of model individuals who would

be visited on a weekly or bimonthly basis. It was felt that the key to a successful extension effort was for the agents not to spread themselves too thin, but to concentrate on thoroughly training a maximum of 25 to 30 farmers over a two-year period. Since demand often exceeded this number, various methods were employed to select potential farmers. The following excerpt from a Peace Corps handout summarizes some recommended approaches:

> These are various methods used by volunteers to determine a worthwhile potential farmer from one who will not make it.
>
> 1. Talking with a contact to determine how serious or determined he or she is.
>
> 2. Insisting on the contact coming to your house to discuss the program and to set up a date for a site visit.
>
> 3. Insisting that the contact visit already existing ponds and talk with other participating farmers.
>
> These methods can help eliminate uncooperative people who would waste the time and energy of the extension agent doing initial pond site visits and follow-ups. If the contact does make the effort to do these things we feel he/she is serious. The site is then visited. One can also tell if a farmer is a hard worker and conscientious by the construction of the farmer's house, the condition of his or her fields, and evidence of other existing agricultural projects and their condition. If the volunteer determines that a site is workable, he or she will advise some initial work to be done. A follow-up visit one to two weeks later will often find no work done and one less potential farmer. If the work has been completed, further advise will be given until the completion of the pond--including stocking, management, feeding and harvesting.
>
> (Steinwand, pp. 3-4)

Thus, the selection process was based on the extension agents' assessments of a number of very subjective criteria in addition to physical considerations at the site itself. Direct contact between extension agents and rural farmers was viewed as the best

way to transmit information to farmers having at best some primary school education. In order to achieve yields on the order of 4000 to 6000 kg/ha/year or even higher, farmers were encouraged to feed twice daily, compost on a regular basis using animal manures and other vegetal material, and do regular maintenance on the dikes and canals. The results of the harvests of these progressive farmers were the most effective form of propaganda for encouraging others to participate.

The concentration on the training of model individuals created a dilemma in the Zairian social context. Problems of jealousy occurred, and will be more fully discussed later. Also, the selection process described above was based on previous experiences in rural situations and was not designed to deal with the high population density and land tenure problems found in the urban area. Increasingly, the desirability of eventually replacing volunteers with Zairian counterparts as originally outlined in the project paper has been called into question. Given that the government is currently unable to provide institutional support for the agronomes[14] it now employs, it seems illogical to add additional agents specialized in fisheries to the payroll. Thus, model farmers are visualized as the future information source in their respective villages.

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[14]The French word agronome will be used for all extension agents working in the Department of Agriculture to avoid confusion with the Peace Corps extension personnel.

Development of the Extension Program in Each Research Site

Several criteria serve as guidelines for deciding whether or not fish pond culture of Tilapia in a particular area was technically and socially feasible. An ideal location would have possessed the following characteristics:

1) High interest among the population.
2) A high population density.
3) Numerous valleys having:
   (a) a year-round water supply,
   (b) water with a pH of 7 to 8,
   (c) clay soils, and
   (d) no dense forest.
4) A widely available variety of leaves, agricultural by-products, and animal manures.
5) A readily available supply of inexpensive tools.
6) Proximity to a major marketplace.
7) Limited or no available supply of fresh river fish.

While no site in Zaire was likely to meet all of these criteria simultaneously, the level of interest among the population was the most crucial consideration. The fact that most water sources examined in Kasai Occidental had a pH ranging from 5.5 to 6.0 and ponds could be constructed in sandier soils meant that less than optimal sites could be utilized if interest in the area warranted it. The rate of diffusion was primarily determined by the population density, the availability of adequate sites, and whether or not sufficient quantities of affordable river fish were found in the local area. Lack of one's own tools did not usually prevent participation, as these were often borrowed when necessary from friends and/or family. The existence of a major marketplace nearby influenced the price at which the fish were sold, and the amount of time necessary to sell all that was produced.

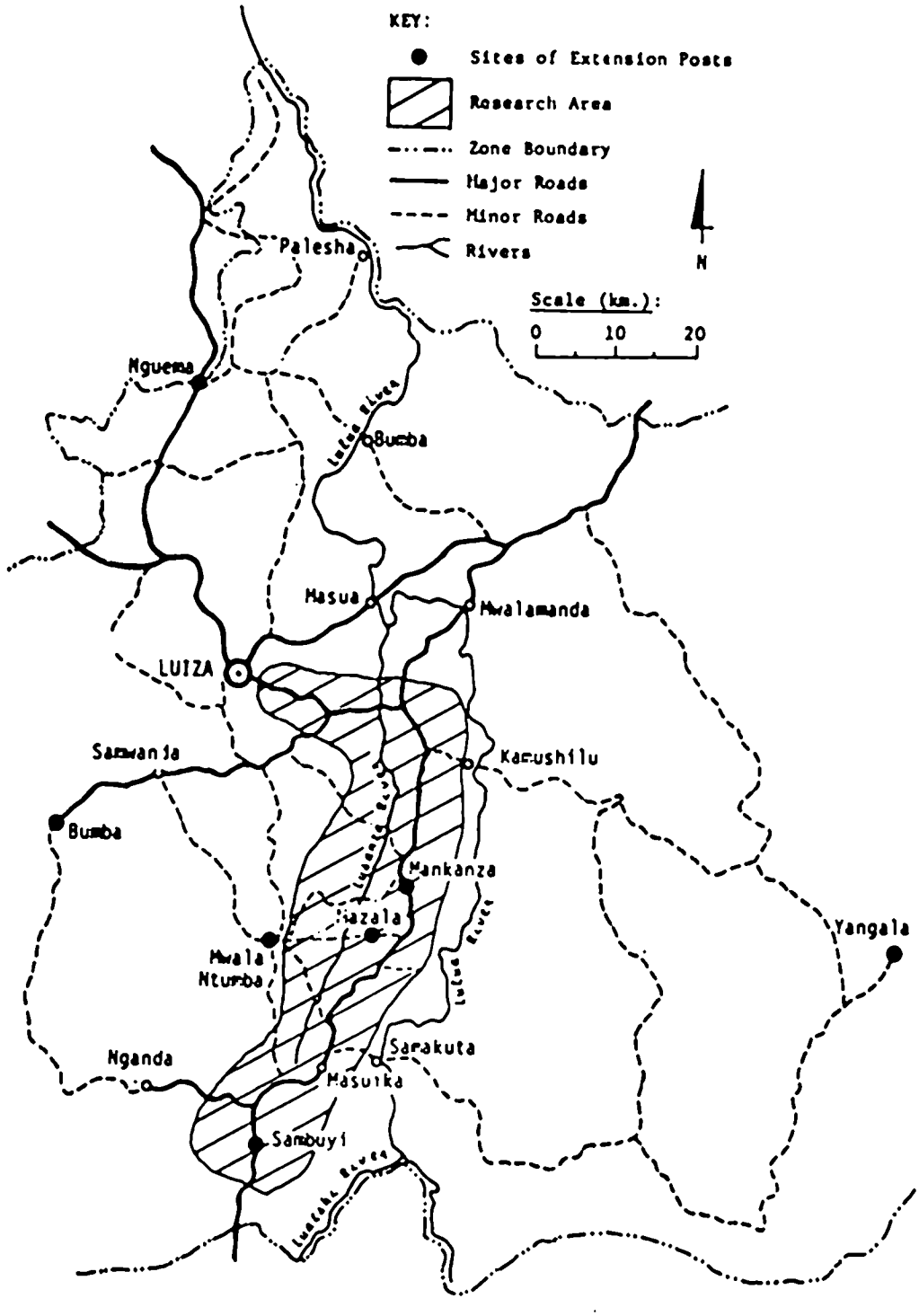
Among the three locations, Luiza possessed the best physical characteristics for fish pond construction as well as the most agriculturally-oriented population. While the eastern side of the Lulua River was sparsely populated (5 to 15 persons per km^2), the western side had a much higher population density (15 to 25 persons per km^2) and predominantly clay soils. Sites were located where numerous suitable valleys were found concentrated in an area, though heavy forestation in some places required many person-hours of clearing. Farmers relied on termites and a variety of leaves (manioc, sweet potato, papaya, etc.) to feed their fish. While virtually no agricultural by-products except manioc peelings were available on a regular basis, the majority of households had access to some sort of animal manure, especially goat, chicken and guinea pig. Hoes and machetes were produced by local blacksmiths in the area, but shovels were in short supply since they came from Kananga, although occasionally limited quantities could be bought through local missions. Major weekly village markets were located throughout the Zone, but the majority of fish were sold at pondside. Fresh fish was widely available at certain times of the year, especially within five to ten kilometers of major rivers, and was price competitive with pond-produced tilapia.

The first pilot post in the Luiza Zone was chosen on the more densely populated western side of the Lulua River, home of the Basala Mpasu. During 1977 and 1978, Mankanza was the sole extension post in the area, with Mazala being added in 1979. Subsequently, interest in fish culture began to spread, with posts being opened

in Sambuyi, Mwala Ntumba, Mundembo, Yangala, Bumba, and Nguema (see Map 2). Higher levels of interest were seen among farmers in the Sambuyi and Mwala Ntumba areas than in the original posts of Mankanza and Mazala. As a result, the extension effort shifted towards the newer areas and the posts of Mankanza and Mazala were closed in 1981. While some of the farmers in and around Mazala continued to receive extension services from the agent at Mwala Ntumba, the remainder were "on their own" after having received two to three years of contact. Thus, returning to the original area provided an opportunity to see at what level the initial participants in the program had continued fish culture activities after termination of the extension service, and to identify problems encountered by farmers in the interim.

The Zone of Dibaya had poorer, sandier soils than those found in Luiza, but a higher population density (28 to 34 persons per km^2). Valley quality varied greatly within the Zone, ranging from broad, lightly forested swamps to narrower valleys with year-round sources of water more suitable to fish culture. Leaves and termites were also available as feed, and many farmers used rice bran during the dry season. Availability of animal manures was fairly limited in the area. Because the area is closer to Kananga than was Luiza, obtaining non-locally produced tools was not as difficult logistically as it was in Luiza. There was even a store run since 1980 by a Catholic development agency (Promotion du Paysan) that was situated near Kalunga Mesu, the oldest extension post in the Zone. The area also had access to the rail line, which meant that

MAP 2. EXTENSION PROGRAM AREA IN THE ZONE OF LUIZA



local markets often received large quantities of dried fish coming up from Shaba. River fish was also prevalent at certain times of the year.

The initial extension post in the Zone of Dibaya was placed near the more densely populated seat of the Sub-Region in Tshimbulu. It soon became evident that the large, wide, swampy valleys around this old commercial center were unsuitable physical sites for pond construction. As a result, the bulk of the extension work quickly shifted from being centered around the large market in Tshimbulu towards the Kalunga Mesu area 70 to 85 kilometers outside of Kananga (see Map 3). The extension effort in that area operated for four and a half years before it was closed in October of 1983. The other posts in the Zone, Mulumba Kabuyi and Ntumba Musanga, were established beginning in 1981. Whereas fifty percent of the initial adopters located in both Luiza and Kananga had "authentic" ponds[15] before the project began, only one of the original participants in the research site around Kalunga Mesu had raised fish prior to the extension agent's arrival in the area. Farmers in this area generally built smaller ponds and there were fewer ponds constructed per farmer than in Luiza or Kananga.

Valleys within the city limits of Kananga were distinguished by the massive eroding hillsides leading down to the valley floor. Many were already partially cleared. The soils were mainly sandy

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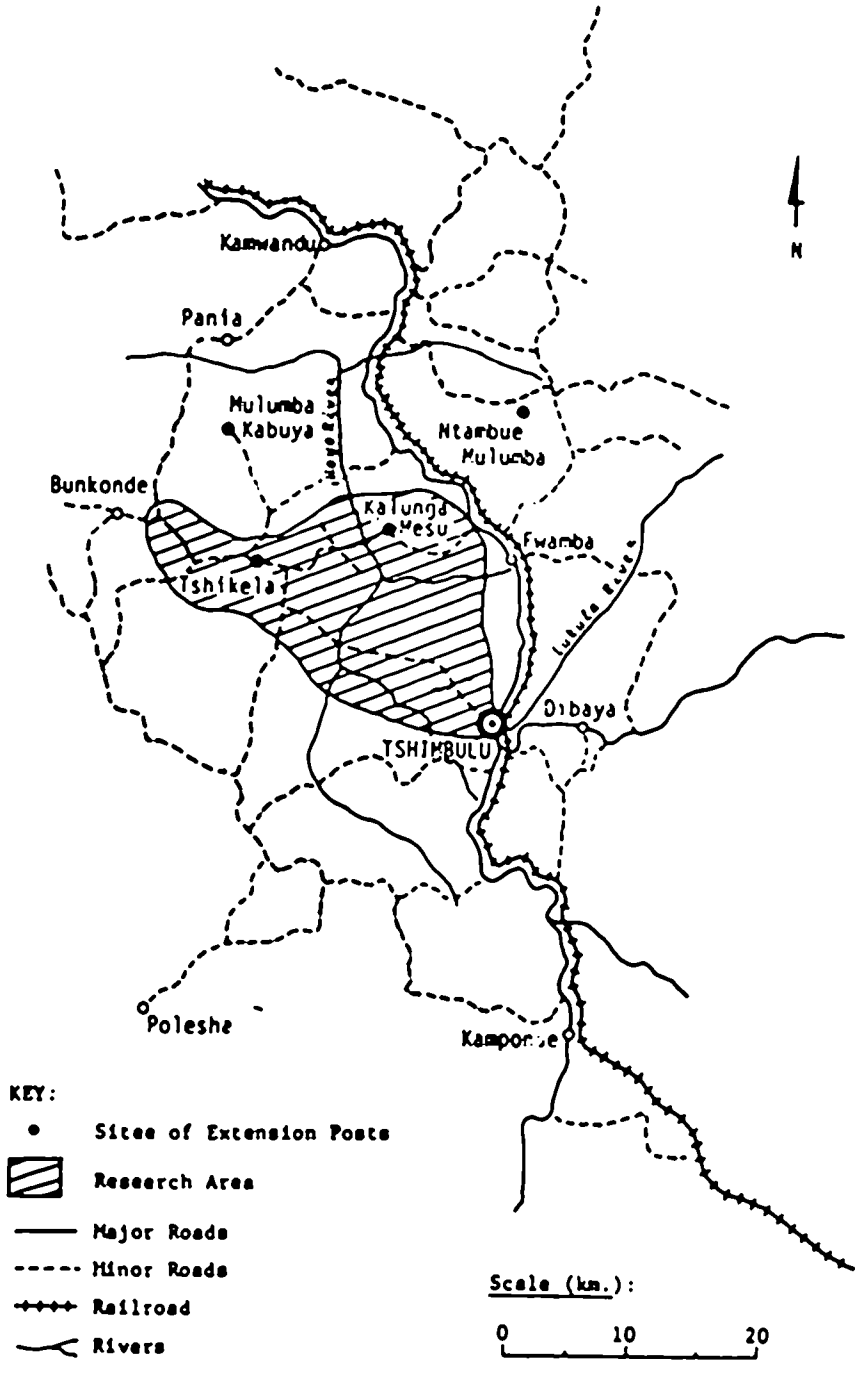
[15]So-called authentic ponds are usually those constructed during the 1950s under Belgian tutelage. Occasionally, they consist of small pools dug out by women to soak manioc in or are pockets created along the river banks for entrapping fish.

MAP 3. EXTENSION PROGRAM AREA IN THE ZONE OF DIBAYA



to sandy clay. Numerous valleys were available for exploitation but several did not have year-round water supplies. Kananga farmers relied mainly on supplementary feeds such as brewery waste, mill sweepings, and manioc peelings. Manioc leaves were principally used for human consumption, not fish feed. Animal manures existed in limited quantities. All tools were readily available, except wheelbarrows. Whether or not the farmer could afford to purchase them was another matter. Two major markets existed, plus several smaller ones located throughout the city. River fish were expensive and in short supply in spite of the fact that the Lulua River was only five kilometers from the outskirts of the city.

The city of Kananga comprises five urban Zones: Kananga, Katoka, Ndesha, Lukonga, and Nganza (see Map 4). These Zones consist of valleys interlacing densely-populated plateaus. Land on the valley floors was of poor agricultural quality and was not in use except for the extensive production of palm nuts. The extension program in Kananga began in 1979 with the establishment of demonstration ponds at an old Belgian fish station in the Zone of Nganza (Katuishi) which was to serve as the Project's regional fingerling center. In addition, a model pond was built at a local agricultural school[16] in the zone of Kananga on the other side of town.

The high visibility of the initial adopters led to an explosion of interest throughout the city in 1981. This resulted in intense competition to claim any remaining sites. Secondary adopters often

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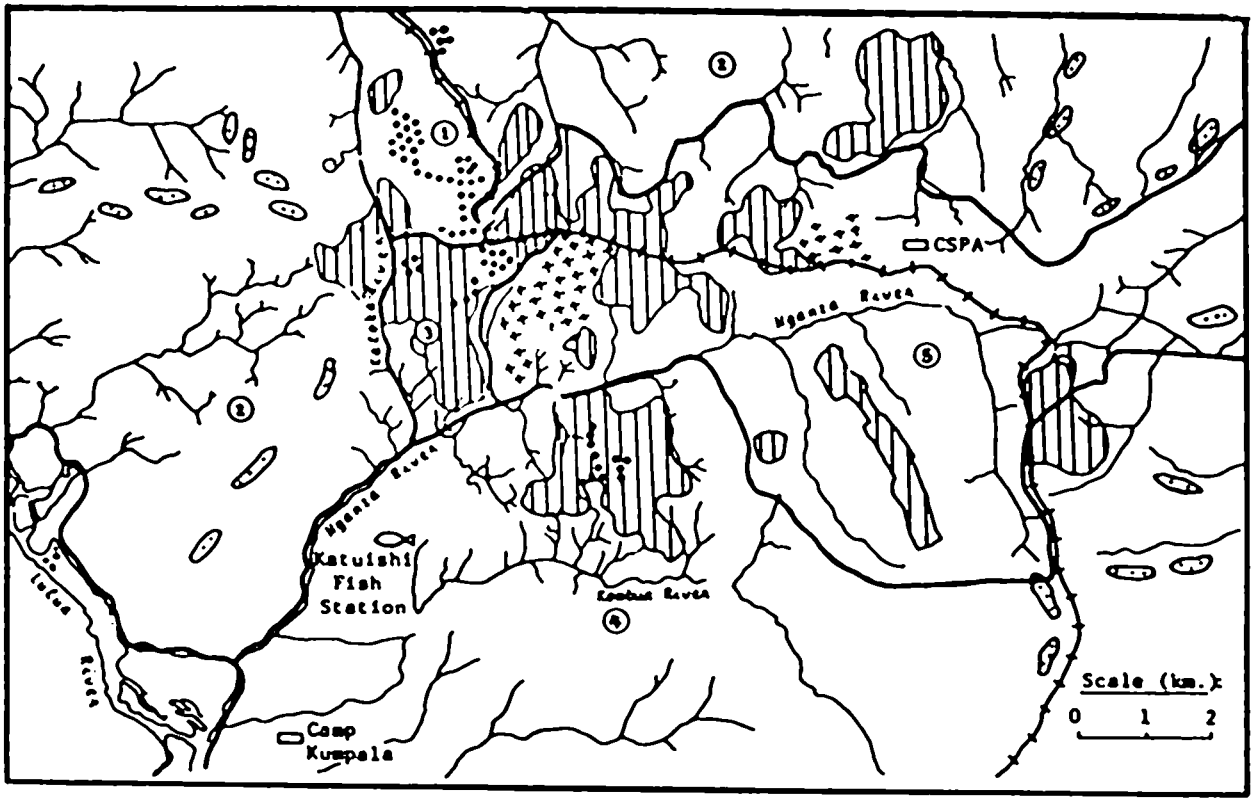
[16]Centre de Specialisation Professionelle Agricole--CSPA on the map.

MAP 4. THE CITY OF KANANGA: ZONES, HYDROLOGICAL SYSTEMS, AND EXPANSION OF THE POPULATION



constructed ponds in valleys either lacking a year-round water supply or, conversely, subject to periodic flooding. In retrospect, while high population density led to a high rate of diffusion, it also resulted in greater incidence of thievery from the ponds, more conflicts over land rights, and numerous incidences of interference from local authorities. On the other hand, the demand for fresh fish was extremely high and some farmers had access to supplementary feeds which enhanced production levels considerably.

By the end of 1979, two primary extension posts existed in Kananga, one at the Katuishi fish station, the other on the outskirts of town at Ntambue. During that time, two agricultural schools in the city (C.S.P.A. and Camp Kampala) permanently incorporated fish culture into their educational programs, having built five and four ponds, respectively. A stable core group of project participants developed during this period, but a substantial number of ponds were abandoned by young men (who made up the majority of secondary adopters) in 1983 subsequent to the legalization of diamond digging in the Demba/Kananga area.[17]

D. The Current Status of P.P.F. in Kasai Occidental

In addressing the question of whether the emphasis on intensive management techniques has yielded significant results, it is useful

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[17]Pond culture was not the only activity affected by this decree. The decision to encourage artisanal production of diamonds in November 1982 resulted in a desired 83% increase between 1982 and 1983 in diamond production moving through official channels. This was reportedly accompanied by a decrease in the traditional smuggling activity (QER (1984), p. 13). The government, however, expressed concern that the liberalization encouraged peasants in the Kasai diamond region to leave their land to dig for diamonds on their own (QER (1983a), p. 14).

to make a gross comparison between what was achieved during the nine year Belgian effort in the Lulua District with that accomplished by the P.P.F. program between 1977 and 1983. Statistics from the 1983 year-end report for P.P.F. in Kasai Occidental are summarized in Table 3. These will be compared to those from 1958, the last year during the colonial period for which production information was available on the District level.

The figures provided by extension agents who were operating in the field in the early 1980s are fairly accurate but limited in scope. This is due to the fact that only the farmers who were being visited at that time are accounted for in the quarterly reports. Any individuals who became independent but were once considered model participants are not included. Nor is there any assessment of the total number of secondary adopters and whether or not they received any extension contact. Moreover, harvest statistics are recorded only for those sites where the agent actually was present or for cases where farmers utilized scales and informed the agent of their results. Unquestionably the figures are incomplete and/or inaccurate; for this reason, the data in Table 3 underestimate the total impact of the project.

The total number of kilograms produced by primary participants under the guise of P.P.F. was far higher than that achieved in Belgian times even though the surface area under production was one-fourteenth that reported in 1958. More specifically, 9385 kilograms of fish were produced in 1983 in the area once known as the Lulua District, a figure 2.6 times the annual production

recorded towards the end of the colonial program.[18] Thus, one of the major goals set out by the project was achieved: total production was raised by teaching farmers how to increase yields.

Table 3. Status of the P.P.F. Extension Program: 1983

	LUIZA	DIBAYA	KANANGA	REST OF REGION	TOTAL FOR REGION[b]
Number of Posts in Zone[a]	5	3	2	5	15
Number of Farmers Receiving Extension Services in 1983	689	133	323	264	1409
Total number of PONDS under PRODUCTION	361	188	239	252	1040
Total number of HECTARES under PRODUCTION	4.64	1.51	3.01	2.89	12.05
RECORDED HARVESTS:					
Total Kilograms	3238	1682	3210	1597	9727[c]
Total Hectares	1.42	0.93	2.10	0.57	5.02
Average Yields (kg/ha/year)	4183	3267	3500	4380	3539

[a]As of mid-1983. All production figures from the Katuishi Fish Station are excluded.

[b]The two posts in the Sankuru which are administered from the Kananga regional office for logistical reasons are not included as strictly speaking they are part of Kasai Occidental.

[c]The posts of Sampashi (Luiza) and a third post in Kananga were closed when volunteers transferred to different areas. The production figures from these areas are included in the year-end statistics.

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[18]9385 kilograms is less than the 9727 figure reported in Table 3 because production data from the zone of Mweka, the only area outside of the Lulua and Kananga Sub-Regions, were excluded.

Though the total number of farmers involved in fish culture was lower, yields obtained by those who did participate were substantially higher. The average yield of 3959 kg/ha/year for P.P.F. farmers was far higher than that recorded at the major government center in Kasai province during Belgian times (1900 kg/ha/year). Obviously, the introduction of a new species combined with intensive management skills led to improved individual farmer performance. While the average yields attained by model farmers were less than those for the regional fish station at Katuishi (6000 kg/ha/year) and far below maximum yields recorded for O. niloticus elsewhere in the world (8 to 15,000 kg/ha/year), it still represented a much more efficient utilization of land resources devloted to pond culture.

Admittedly, though the above comparison is rough, it does lead one to the conclusion that the basic technological package promoted by the project was sound. If production levels such as these were maintained over the long-run as increasing numbers of farmers joined the program, the project would be deemed a success. Nonetheless, technical acceptability is not the only criterion. The profitability of raising fish versus engaging in other activities, the management skills required, and the continued presence of the extension service are additional factors which will determine whether or not such production levels can be sustained in the long run.

III. METHODOLOGY

In designing and implementing the survey, several factors had to be taken into account. First, the limited time in which the work had to be done (four months) meant that most of the information had to be obtained from recall data rather than by direct observation over a complete production cycle. Second, the questionnaire had to be comprehensive enough to cover conditions encountered in both the urban and rural settings. Third, the fact that the researcher had previously worked in the project automatically introduced a personal bias which needed to be minimized as much as possible.

The initial design consisted of five parts:

1) A general socio-economic survey describing the participants, their reasons given for participation, major problems encountered in raising fish, how money from the ponds is spent, and the relative importance of fish culture as a means of generating income.

2) A detailed follow-up survey which would seek more specific data on the actual costs and benefits of fish and crop production.

3) A frequent interview survey which could provide daily expenditure and labor input data for a portion of the total sample.

4) A market survey of local prices for major sources of protein and carbohydrates in each area.

5) Soil sampling in each area to provide a general picture of the nature of the soils.

Before departing for Zaire, two drafts of each of the first three questionnaires were prepared and modified following consultations with professors at Cornell. Documents on previous research done in West Africa by Spencer (1972), Norman (1973), and Matlon (1980)

proved to be especially useful with regard to the phrasing of direct and indirect questions aimed at the rural farmer, as did more general works on farm management (Casley (1981), Brown (1979), Stanton (1973), Collinson (1972), Upton (1973)). The Tshiluba version of the questionnaires was pre-tested for a period of two weeks based on six households in the Kananga area. This led to modifications which were incorporated into the form ultimately used in all areas. The pre-testing proved invaluable for pointing out pitfalls in question comprehension and limits in the attention span of those being interviewed.[1] It also highlighted the logistic problems involved in setting up interviews. Though the time constraint prevented any pre-testing in a rural area, very few further modifications had to be made in question design once there. On the whole, the ability to recall numerical data was better among urban residents than for their rural counterparts. Thus, if any rural pre-testing had been done, it most likely would have resulted in additional simplification of the second, more detailed survey.

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[1]The accuracy of responses to a question asking what year the farmer started working with the extension service was indicative of the danger inherent in trying to gather information by relying on a farmer's ability to recall past events. A list of the year in which each participant began in the program had been obtained from the extension agents in Kananga and Dibaya. The responses of 33% of Kananga's initial adopters and 30% of Dibaya's initial adopters differed by one to four years from the extension agent's list. All questions in the general survey requiring a numerical responses were restricted to the current year (1983).

A. General Survey

In order to meet the objective of assessing project impact as a function of degree of exposure to the extension service, farmers were sub-divided into four categories:

1) Initial adopters: Farmers who had worked extensively with the original extension agent in the area and brought ponds into production during the first two years of the program.

2) Secondary adopters: Farmers who built ponds on their own, subsequently receiving minimal or no extension contact.

3) Drop-outs: Farmers belonging to either of the above two categories who had abandoned their ponds.

4) Non-participants: Those persons living within the project radius who never built ponds.

Complete lists of initial adopters in Kananga and the Zone of Dibaya were obtained from the original extension agents. A partial list was compiled for the Zone of Luiza as only one of the two original extension agents in that Zone could be located. The names of the remaining initial adopters were provided by other participants in Luiza. In Kananga and Luiza, farmers to be interviewed were randomly selected from these stratified samples. All initial adopters in Dibaya who had not permanently left the general vicinity were included in the survey.

A breakdown of the current status of all the initial adopters considered is shown in Table 4:

Table 4. Sample of Initial Adopters: Current Status

AREA	Year Extension Program Started	Total No. of Initial Adopters in Area	Percent of Adopters: with ponds in production in 1983	included in study	having contact with an agent in 1983
KANANGA	1979	25	92[a]	72	66
LUIZA	1977	22	82[b]	63	18
DIBAYA	1979	18	83[c]	83	33

[a]Two of the original farmers had died.

[b]One farmer had died; two had abandoned their ponds. Ponds of one of the deceased farmers remained in production under the responsibility of a cousin.

[c]Three farmers moved to another area.

From 63 to 83 percent of the initial project participants in each area were included in the study. Extension contact during the year prior to the study varied from 18 to 66 percent. Differences were related to their proximity to the most recent extension agents operating within the particular Zone. The fact that 66% of the farmers in Kananga had been visited in 1983 as compared to only 18% in the Zone of Luiza is reflected in the better record-keeping noted among urban farmers.

For the remaining categories, there were no relatively complete lists of names to draw upon, nor were aerial photographs available. Secondary adopters and drop-outs were chosen in two different ways. In the case of Kananga where numerous farmers can be found in a single valley, the valleys themselves were randomly selected from

a list of all valleys containing ponds. Each valley was surveyed with a resident of the area and a list compiled of the names of all farmers in the valley. Farmers were randomly selected from that list and divided into secondary adopters and drop-outs. Obviously, it was not possible to include drop-outs who had moved out of the area. In that respect, the results are biased towards those individuals who abandoned fish culture but chose to remain in Kananga. The majority of those who left were young men said to have gone to dig diamonds, either in Tshikapa, Mbuji Mayi or the Demba area.

The whereabouts of secondary adopters and drop-outs in the rural sector had to be ascertained through talking with local residents or initial adopters who had sold fingerlings to them. Farmers were randomly selected from this list. It was necessary, however, to exclude some of those who were located a considerable distance from the center of the survey area because of the limited time available. In some instances, it so happened that a secondary adopter was encountered when using the method described below for selecting non-participants.

In both rural sectors, non-participants were chosen by picking an arbitrary starting point, driving 5 kilometers down the road, stopping in the first village that appeared after the 5 kilometer mark was reached and identifying the farmer living in the fifth house on the right. It was found that the best time for doing this was on Sunday, as male farmers were much more likely to be present. The purpose of the study was explained and an appointment set up for the coming week. In Luiza, having to reset appointments became

a time-consuming affair as heavy rains on certain occasions made the clay roads impassible. In three instances in Luiza, the farmer living in the 10th house on the right in a particular village was interviewed when the original choice was not present. This procedure was adopted to avoid having to make a return trip.

The technique employed in rural areas is not feasible in urban areas owing to the myriad of roads and dense population. For this reason, a shortened roadside survey was used in Kananga. Two mornings were spent on each of the three major arteries going into the city center from the surrounding residential quarters. The interviewer chose every 10th adult male that passed by. A third of the individuals stopped in this manner refused to participate. Those that did were an amalgam of both employed and unemployed males. In total, twenty-one non-pond-owning men were interviewed.

All farmers who currently had ponds as well as drop-outs were very willing to be surveyed. The average interview lasted one and a half to two hours plus the time it took to walk to and from the pond site. Obtaining answers in the valley floors was beneficial. Not only could one verify the actual size and condition of the ponds, but in addition one could obtain information more readily when other family members were not around.[2] A standard presentation was made explaining the purpose of the study and assuring the farmer that

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[2]In several cases, male farmers requested that their wives be present to aid in recalling events. In one instance in Luiza a young farmer insisted that his uncle be present. When the question as to whether or not he owned cattle arose, the farmer first turned to his uncle and discussed the matter in Tshisala. I presume the uncle gave his permission, as the young man then disclosed that he did own two head.

the information would be kept confidential and his or her name not revealed. Initially, emphasis was placed on asking easy-to-answer questions such as a request to list problems they had encountered in raising fish. An English version of the questionnaires is provided in Appendix A.

All interviewing of the initial adopters was done by the author. An assistant, Tshibuabua Binye, was hired in the city. He conducted the majority of the surveys among secondary adopters, drop-outs and non-participants in Kananga. The use of an assistant made it possible to continue the survey in the urban area while the author was conducting interviews in Luiza and Dibaya. As only a month was available in each of the rural areas, it was not possible to identify and train any Zairian assistants. Two Peace Corps fisheries volunteers who had or were currently working in the zone assisted with some of the interviews of secondary adopters and non-participants. Because of this assistance, the sample size of the study was twice that which would have been possible otherwise. However, it does mean that an additional potential source of bias was introduced in the non-initial adopter interviews.

In all, 153 heads of households were interviewed, of which 46 were initial adopters still raising fish; 44 were secondary adopters of which 54% had never had any contact with the extension service, 26 were farmers who had abandoned their ponds; and 37 were non-participants.

B. Survey of Costs and Returns Associated with Fish Ponds

Second and, in some cases, third interviews were conducted among eleven households in the urban area, six households in the Luiza Zone, and five households in the Zone of Dibaya. Farmers included in this survey were not randomly selected from the list of initial adopters in the general survey as originally intended. It was decided that it would be more valuable to include those farmers who kept records and/or had better recall ability than those who did not.

The major objective of obtaining more detailed information was to be able to compare the variation in gross margins from operating fish ponds in the urban versus the rural households. Unfortunately, only 6 farmers had kept relatively complete and accurate pond records since the inception of the program, and all of them were from the urban area. Moreover, labor data proved to be extremely difficult to collect, especially that regarding the amount of time invested in pond construction and management. However, it is possible based on these data to make some assessment of the relative contribution of labor made by the men and women of the household and the distribution of proceeds received from the sale of fish.

In addressing the issue of who handles the cash within the family, the head male and female in the household were interviewed separately whenever possible so that their individual answers could be compared. In the one case where disagreement occurred, the woman's answer was chosen as it was similar to others obtained in the same area. In the zone of Luiza, only the men were questioned as the women in these households did not speak Tshiluba or were unavailable.

C. **Frequent Interview Surveys**

Daily labor activity and household expenditures were gathered from among nine households in the Kananga area during a two month period. Four farmers who were literate wrote down the information for themselves and the other five households, which were visited every other day. Among the heads of the nine households, two lived 15 kilometers outside of the center of town and could be classified as cultivators. Four of the remaining seven families had fields, but the heads of these households also had jobs in town. Though it would have been desirable to have conducted frequent interviews in Luiza and Dibaya as well, there was insufficient time available to train enumerators and collect further data in those areas.

D. **Market Survey**

A weekly survey of the prices of principal foodstuffs in Kananga was conducted in its largest market, Marche Mama Mobutu. Several purchases were made each week, and the products were weighed in order to be able to compare the relative costs of different sources of protein versus fresh tilapia, as well as sources of fish food, such as manioc leaves. In order to calculate what it would cost to produce one kilogram of dried pond tilapia, ten kilograms of fresh fish were smoked at the regional fish station, the labor input for each stage of the operation being recorded.

Single-visit market surveys were also made in Luiza and Dibaya so that the relative prices of different foodstuffs which were available in the three areas at the time of the survey could be determined.

In addition, changes in the prices (from 1978 on) of various important inputs in pond culture, such as shovels, machetes, and brewery waste were obtained from local merchants in Kananga. A limited amount of secondary data on market prices also was obtained from the regional Institute National de la Statistique.

E. Soil Sampling

Very little information on the soils of Kasai Occidental is available. Only the research area in the Zone of Dibaya had been included in the massive country-wide soil survey undertaken by the Belgians (Gilson and Liben (1960)). It was decided, therefore, to do some very limited sampling in each of the areas. Soil from a recently drained pond bottom was to be compared to soil not currently being cutivated in the same valley floor. Differences in potential for crop production were expected to be seen by comparing soil from the valley floor with that on the adjacent hillsides. In the rural areas, hillside sites selected had either never been cultivated or had not been touched in many years. The same can not be said for the Kananga area where erosion is a severe problem and little land, at least near the city center, remains unused for significant periods of time.

Each sample was based on a mixture of the first eight centimeters of soil from ten different measurements. Individual measurements were seven meters apart on the hillside and valley floor, and two meters apart on the pond bottom. Samples were sun-dried before shipping to the Cornell Agronomy Department for analysis.

IV. CHARACTERISTICS OF THE RESEARCH AREAS

A. Physical Description

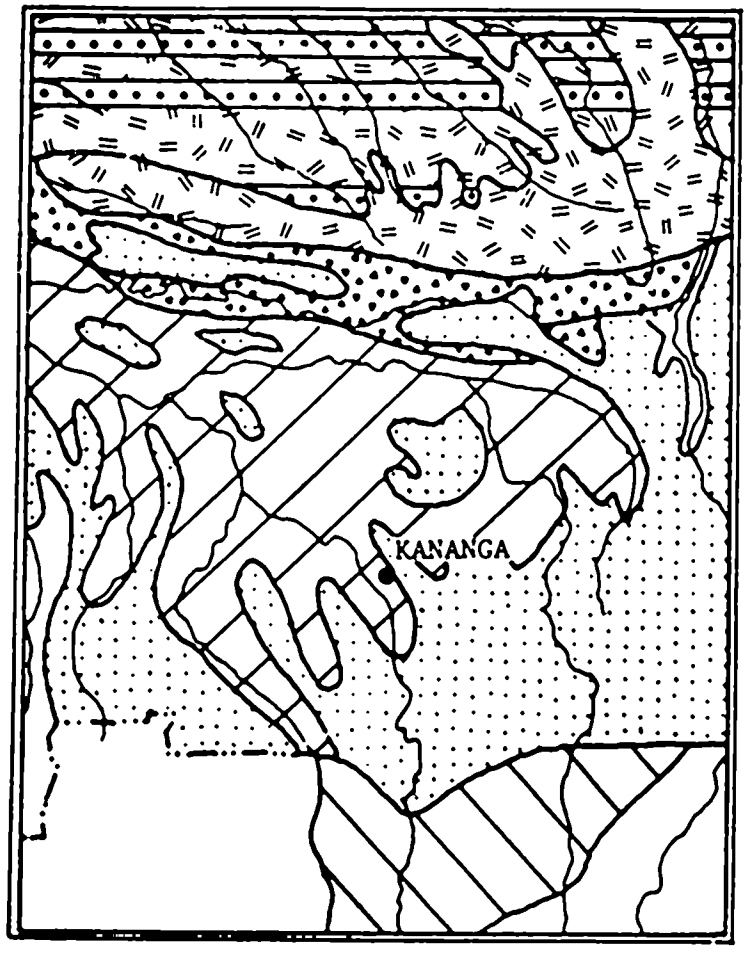
Kasai Occidental is part of the sandy plateau which borders on the immense primary forests of Zaire's central basin. The maximum altitude of 950 meters found in the southern part of the region descends to 650 meters in the north. This fairly uniform relief is irregularly sliced by a dense hydrographic network. Many areas consist of steeply sloped valleys interspersed with finger-like projections of savanna (Beguin, p. 21).

The majority of the research area in this study falls under the classification of "guinean" bush savanna or is a mix of semi-deciduous forest and savanna (see Map 5). Savanna found on the plateau is either the original outgrowth of the biological and chemical characteristics of the soil itself or the result of clearing and burning a previously existing forest. The microclimate of remaining forests in the valleys is more humid than that of the surrounding savannas, the soils being protected from leeching rains by the extensive vegetative cover.

Soils

Like many tropical soils, those of Kasai Occidental are highly decomposed due to the hot and humid climate. The sandy surface coverings are a reflection of the light soils having little water retaining capacity, humus content, or soluble inorganic elements. The soils tend to be rich in iron and aluminum, both of which can

MAP 5. VEGETATION OF THE KASAIS*



Dense semideciduous forests and islands of savanna

Wooded Guinean savanna

Mixed formations in transition

Mixture of semideciduous and evergreen forest; some islands of savanna

Dense evergreen forest on solid ground

Swampy, inundated forest

*Adapted from Jeune Afrique, Atlas de la Republique du Zaire (1978), p. 21.

be hydrolized into insoluble forms. Free as sesquioxides during the rainy season, they dehydrate and harden in the dry season. In the more extreme cases, this can result in the formation of sterile lateritic plates resistant to any vegetative regrowth.

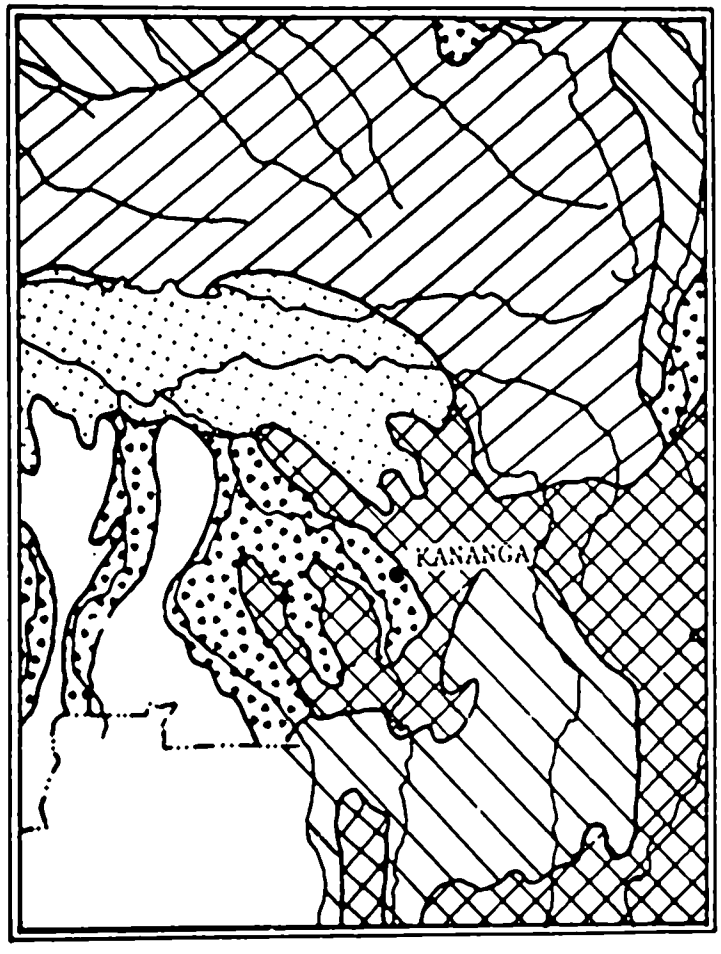
The condition of the soils found in the research area in Dibaya is particularly bleak (see Map 6). Gilson and Liben (1960) classified them qualitatively as being of very poor agronomic value. With a clay content of only 8 to 15% and a very weak capacity for water retention, they hypothesized that even inorganic fertilizers would be of limited value in enhancing crop production.

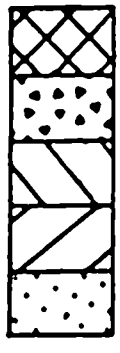
Further south, the iron containing soils of Luiza are richer in clay content (>20%), and are of a higher agronomic value, particularly in the dense forests. Once the protective cover of the forest is disturbed, however, the essential nutrients are depleted more rapidly.

Soils in all areas are acidic, with pH values ranging from 4.3 to 5.7. This explains the acidic nature of the water as well (generally found to be pH 5 to pH6). Results from the analyses made in each Zone are shown in Table 5. Considerable variability was found among the sites in each Zone. As the number of samples collected was very limited, it is impossible to infer much from these data.

The percent content of organic matter in a soil is a crucial consideration since it is the sole source of nitrogen. While one normally expects to find a percentage ranging from 3 to 5% in humid, <u>temperate</u> soils, even lower values were seen in these tropical examples. At each site, the sample from the valley floor had a higher organic

MAP 6. SOILS OF THE KASAIS*





Extremely degraded soils under savanna conditions (arenoferrals)+

Mixture of weakly ferralitic soils (ferrisols) and extremely degraded soils under forest conditions (arenoferrals)

Ferralitic soils in dense forest (ferralsols)

Extremely degraded soils under forest conditions (arenoferrals)

Weakly ferralitic soils

*Adapted from Jeune Afrique, Atlas de la Republique du Zaire (1978), p. 23.
+Soil classifications according to Sys (1961).

Table 5. Results from the Soil Analyses

	Organic Matter	pH	Exchange Acidity	Phosphorus	Potassium	Magnesium	Calcium	Iron	Aluminum
	(percent)		(me./100 g.)	(.	. . . . .	micrograms/gram	. . . . .	. . . . .	.)
ZONE OF LUIZA									
Site Number 1									
Hillside	3.5	5.5	13	<0.5	74	181	1190	<2.5	59.3
Valley Floor	3.8	5.2	21	<0.5	50	200	630	9.9	179.6
Pond Bottom	1.7	5.4	13	<0.5	24	445	1630	21.0	50.2
Site Number 2									
Hillside	3.3	5.7	11	0.5	91	205	1160	<2.5	25.5
Valley Floor	3.9	5.5	17	<0.5	82	260	1040	2.8	90.3
Pond Bottom	1.4	5.2	14	<0.5	40	142	420	143.5	83.6
ZONE OF DIBAYA									
Site Number 1									
Hillside	1.9	4.4	9	0.7	23	8	<50	21.5	129.8
Valley Floor	2.5	4.9	9	0.5	37	24	100	30.6	131.7
Pond Bottom	1.6	5.1	6	<0.5	10	8	50	114.0	73.4
Site Number 2									
Hillside	2.4	4.6	9	0.8	42	19	50	20.3	135.6
Valley Floor	4.9	4.3	20	1.5	42	23	50	176.5	107.3
Pond Bottom	0.7	4.6	4	0.8	25	7	<50	44.9	36.8
Site Number 3									
Hillside	2.6	4.6	12	<0.5	39	28	50	17.8	212.3
Valley Floor	3.5	4.5	13	0.6	66	22	80	33.9	190.5
Pond Bottom	1.6	5.1	7	<0.5	13	8	50	151.0	110.7
ZONE OF KANANGA									
Site Number 1[a/]									
Hillside	1.6	5.2	3	1.4	32	38	110	4.0	31.1
Valley Floor	2.3	4.7	8	13.0	40	54	110	275.0	23.7
Pond Bottom	3.5	4.7	11	3.4	47	59	270	155.0	50.7
Site Number 2[b/]									
Hillside	1.3	5.0	3	1.1	40	18	90	6.5	47.4
Valley Floor	1.8	5.4	3	2.6	53	28	120	9.0	26.0
Pond Bottom	1.4	4.7	3	1.4	33	16	80	95.0	24.4
Site Number 3[c/]									
Hillside	2.9	4.8	8	0.7	73	20	90	22.5	142.8
Valley Floor	5.6	4.5	20	0.7	50	15	<50	[illegible].5	206.2
Pond Bottom	5.1	4.7	12	0.6	23	13	<50	[illegible]	138.1

a/ Sample from a farmer's site on the outskirts of the city.

b/ Sample from a sandy area in the middle of town.

c/ Sample from the ponds and surrounding area at Katuishi fish station.

matter content than that from the hillside. This would be expected as valuable nutrients washed from the hillsides would settle below in the valley floor.

Organic matter content was also greater in the valley floors than in the pond bottoms, except for the samplings made at the regional fish station. This was somewhat unexpected as Avnimelech and Lacher (1979) have indicated that fish ponds utilized for intensive culture are characterized by their very high nutrient load. Their study found that the top 20 cm from a pond bottom contained high concentrations of organic carbon, nitrogen, and phosphorus by comparison to equivalent layers of the surrounding soil. It is probable that the Kasai sites were not as intensively fed (except at the fish station site), and that the farmers removed most of the topsoil when building the pond. The bottom layers of the pond sediment are poor in organic matter due to decomposition, leaching, and the lack of additional organic matter being accumulated while the pond is in production (Avnimelech and Lacher, p. 6). The concentrations of magnesium and calcium were considerably higher at all locations in the two Luiza sites than for samplings taken in Dibaya and Kananga. Otherwise, nutrient values were fairly low to average, except for iron and aluminum in certain locations.

Climate

The areas under consideration lie from six to eight degrees south of the equator. As such, they lack the equable rainfall distribution found in the central basin to the north. Using Walsh's

(1980) classification scheme for tropical climates, this part of Kasai Occidental falls under the "wet seasonally dry" category as four months out of the year receive less than 102 mm of rain. The past 19 years of rainfall data for Kananga were used to calculate a seasonality index of .46, meaning that the climate was rather seasonal.[1] The index can vary from 0.00 (if all months have equal amounts of rain) to 1.83 (if rain is concentrated into a single month). The reliability of the rainfall pattern and quantity of rain received strongly influences farmer's decisions about agricultural activities. Reliability tends to be higher when relative seasonality is lower (Walsh, p. 16). The low seasonal index found for Kananga means that farmers in this area can count on fairly reliable onsets of the rainy seasons. The year 1983 was highly unusual, however. As can be seen in Figure 1, seven out of twelve months received below average rainfall when compared to preceding years. The author encountered farmers planting maize as late as the end of October, an activity that is usually done in September and early October.

The average annual precipitation for the region varies between 1400 and 1770 mm. The bimodal pattern results in two rainy seasons--the longer from September through mid-January, the shorter from mid-February until the beginning of the dry season in May (usually between the tenth and the twentieth). The dry season lasts from 92 to 114 days from its commencement in May through most of August. The so-called

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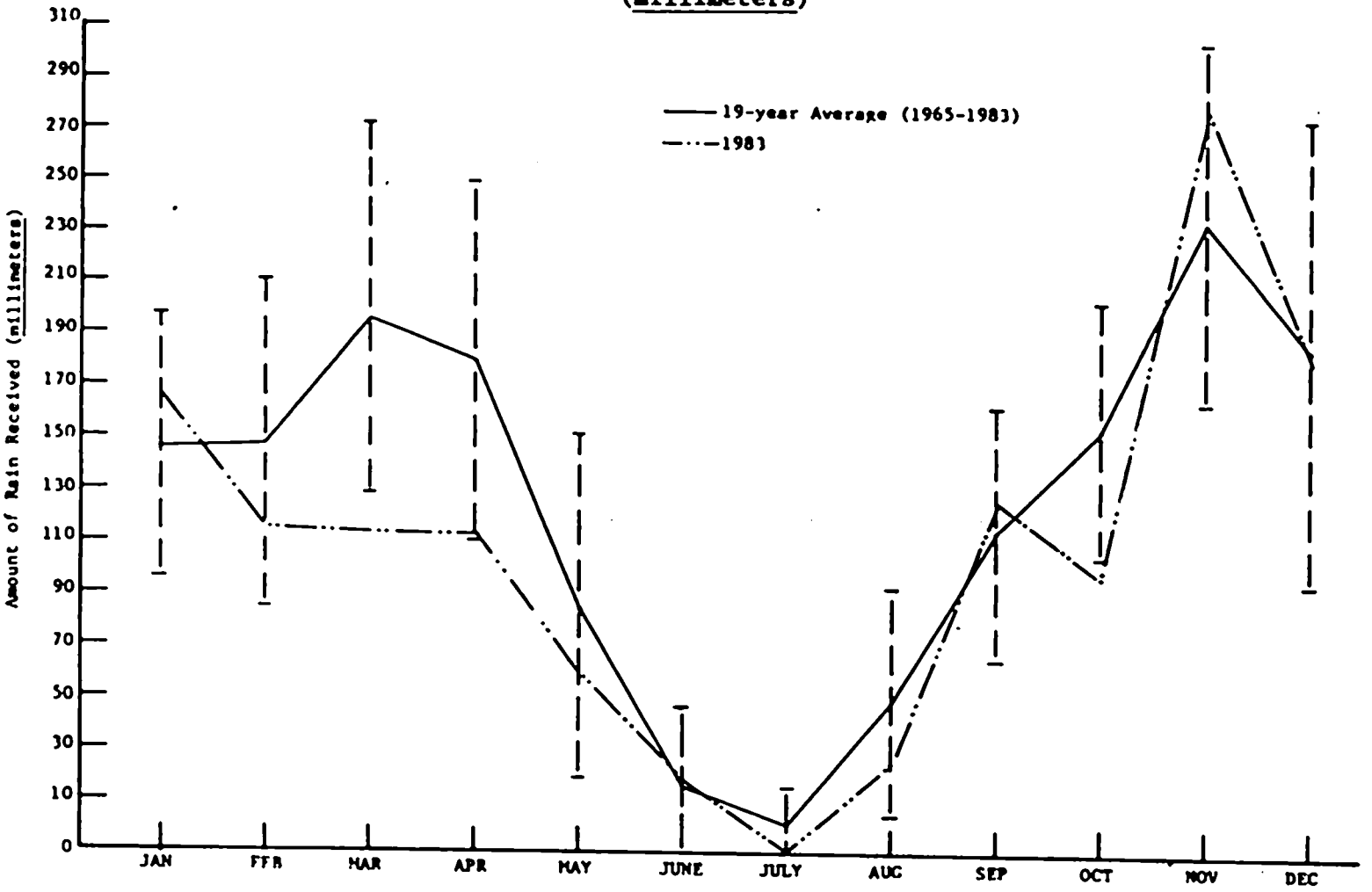
[1]The seasonality index is the sum of the absolute deviations of mean monthly rainfall from the overall mean, divided by the mean annual rainfall. (Walsh, p. 14)

FIGURE 1. MEAN MONTHLY RAINFALL

(millimeters)



*Data from John Miller for Years 1965-82; C.S.P.A. for 1983.

"little" dry season lasts approximately one month during January and February (Beguin, p. 18).

The average annual temperature hovers around 24 to 25 degrees Centigrade and does not vary much from month to month (see Figure 2). Diurnal variations in temperature can be very significant in the dry season. The lowest average monthly temperature occurs in July, corresponding with the height of the dry season. Relative air humidity also falls from near 80% during the rainy season to between 47 and 57% in the dry season (Beguin, p. 19).

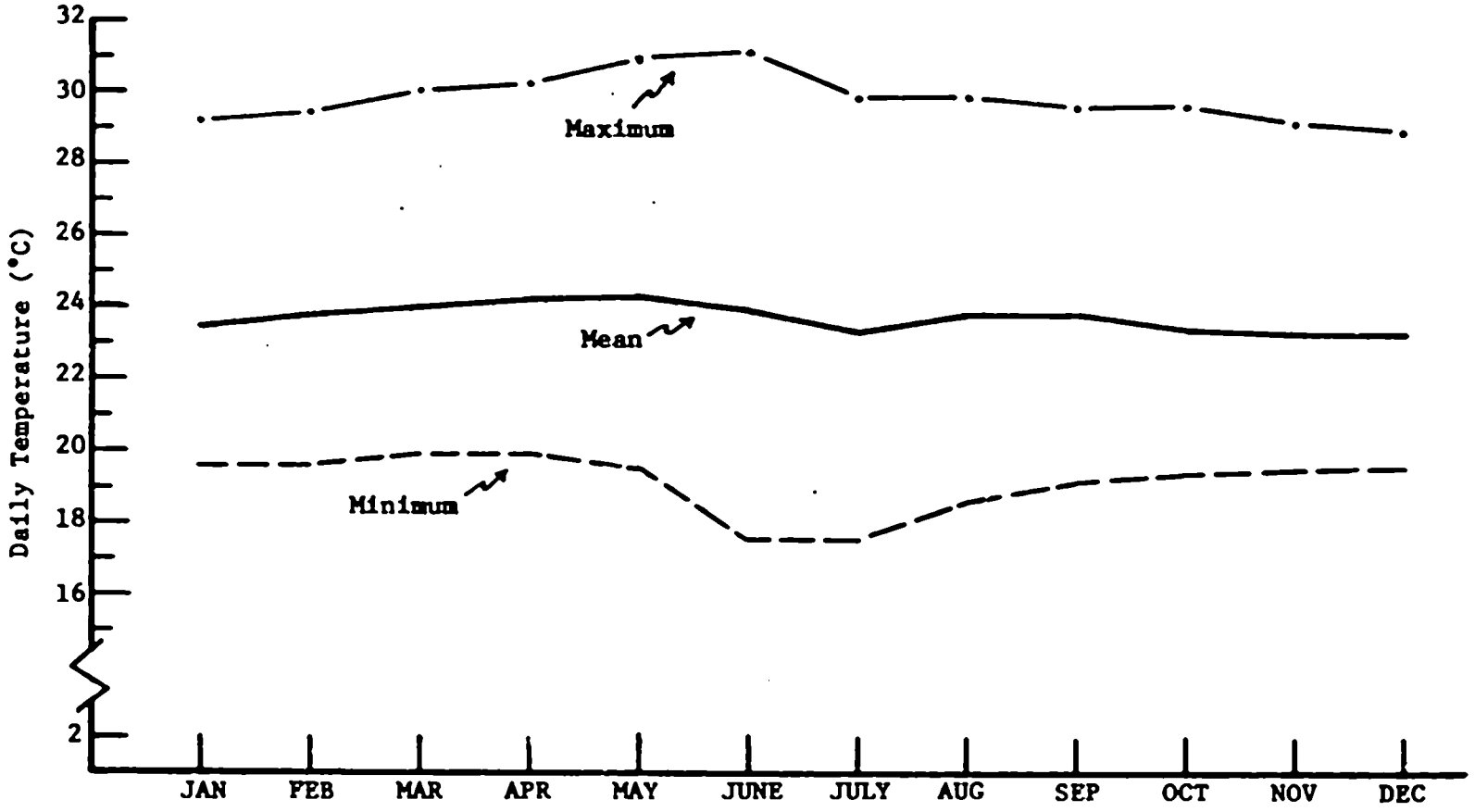
B. Ethnic Composition

The extent of ethnic diversity in the Kasais is immense (see Map 7). The Baluba, Bena Lulua, Bakuba and Batetela predominate in total numbers. Tshiluba, the mother tongue of the Luba and Lulua peoples, is the dominant language in the two Kasais, though its adoption is heavily resisted among the Batetela and the Basonge. The individuals encountered in this study were principally of Lulua (14-28) or Sala Mpasu (33) origin. The latter group is concentrated between the Lulua and Lueta rivers in the Luiza Zone. The demographic structure of much of the area was reshaped in the early 1960s due to violent intertribal conflict between the Bena Lulua and the Baluba.

Kananga

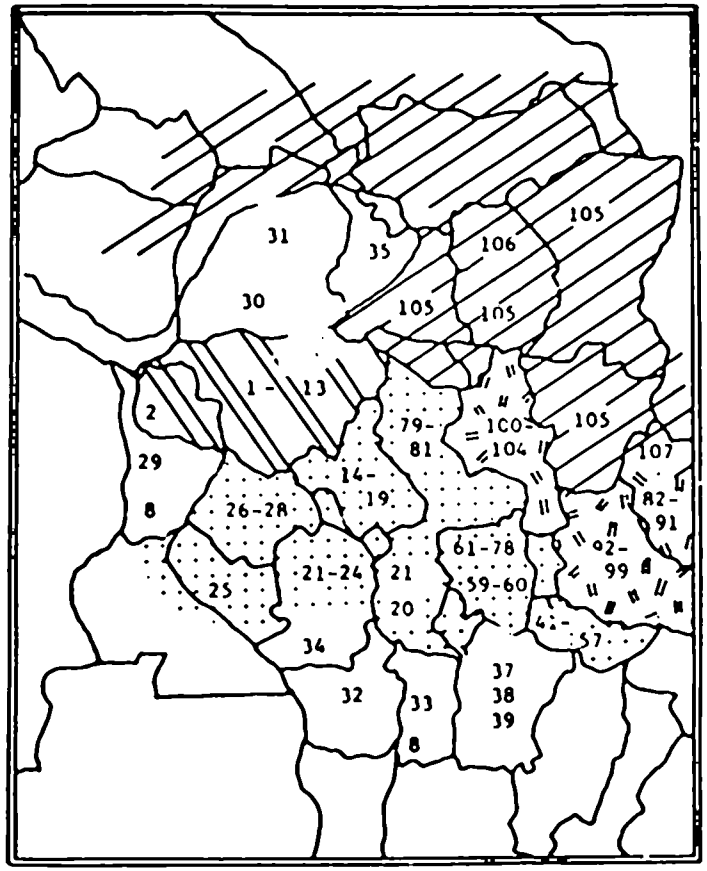
The Baluba and Bena Lulua are, in fact, of common origin: the precolonial Luba Empire between the Lualaba and Lomami rivers

FIGURE 2. MEAN AVERAGE, MINIMUM AND MAXIMUM DAILY TEMPERATURES IN KANANGA*



*Data from Institute National pour l'etude Agronimique du Congo Belge, Atlas Climatique, Table 28 (Brussels, 1971).

MAP 7. ETHNIC COMPOSITION OF THE KASAIS*



Bakuba
Luba
Mongo
Basonge

BAKUBA
1 Bushongo (Bambala)
2 Bakele
3 Bapianga
4 Bangende
5 Bangongo (Bakongo)
6 Bangombe
7 Bashova
8 Bakete
9 Bulangu
10 Maluku
11 Bokila
12 Bieng
13 Bambengi

LUBA
Bena Lulua
14 Bena Kasengenaie
15 Bena Tshadi
16 Bakwa Mushilu
17 Bena Mamba
18 Bena Mukuna
19 Bena Mbanga
20 Bakwa Mdale Kasansu
21 Bashila Kasanga
22 Bakwa Kataua
23 Bakwa Mulume
24 Bena Ngoshi
25 Bakwa Mlambi
26 Bena Kapuku
27 Bena Kongolo
28 Bashila Pambi

OTHER
29 Bashilele
30 Basongo Meno
31 Mdengese
32 Balwalwa
33 Basalampasu
34 Babindji (Bambengani)
35 Bankutshu
36 Bayashi
37 Bena Kanioka
38 Bena Kaniki
39 Bena Kanitshin
40 Tutshokwe

LUBA
Baluba du Kasai
41 Bena Ngandu waNjika
42 Bena Kalambayi
43 Bena Mahimba
44 Bena Mpiana
45 Bena Mande
46 Bena Matamba
47 Bena Nsana
48 Bena Kaniana
49 Bena Kasehi
50 Bakwa Mulumba
51 Bena Lonji
52 Bena Mpunga
53 Bena Mwembia
54 Bena Momba
55 Bena Tshizubu
56 Bakwa Tshinene
57 Bena Kapuya
58 Bakwa Mtembwe
59 Bena Malenga
60 Bena Bitende
61 Bakwa Dishio
62 Bena Mpuka
63 Bakwa Kalonji
64 Bakwa Nsumpi
65 Bakwanga
66 Bakwa Bowa
67 Bena Tshitolo
68 Bakwa Mdoba
69 Bakwa Kanda
70 Bena Kabindi
71 Bakwa Sumba
72 Bambu
73 Bajila Kasanga
74 Bakwa Nyanga
75 Bakwa Mpuka
76 Basangana
77 Bena Mpoyi
78 Bena Bulanga

LUBA
Bakwa Luntu
79 Bakwa Pungwe
80 Bakwa Kasinga
81 Bena LuSi

BASONGE
82 Bapina
83 Bena Ngongi
84 Bahemba
85 Bena Lutobo
86 Balaa
87 Baka Kala
88 Bena Puku
89 Bena Ngongo
90 Benebomba
91 Bekalebwe
92 Basanga-Bakankala
93 Benchi
94 Bena Mziba
95 Bena Mpanza
96 Belande
97 Bamilembwe
98 Bena Budya
99 Bena Mala
100 Batempa
101 Bakwa Mhoto
102 Bena Mona
103 Betundu
104 Bena Mitondo

MONGO
105 Batetela
106 Bahamba
107 Bena Imbiadi
108 Bena Lunia
109 Bena Inga

*Adapted from Jeune Afrique, Atlas de la Republique du Zaire (1978).

in what is now North Shaba.[2] They were to be divided into two distinct ethnic groups under the impact of colonialism and modernism (Nzonlongola-Ntalaja, p. 103). The Bena Lulua were noted hunters, who unlike the more agriculturally-oriented Baluba, resisted the colonial intrusion on their social structure. The Baluba were among the first to be educated in the mission system and held the majority of higher salaried positions open to Africans in Kananga. By 1957, the Baluba outnumbered the Bena Lulua in Kananga by two to one (56% versus 25% of the total population), even though the latter considered themselves to be the first occupants in the vicinity (I.N.S., p. 8). When the first stirrings of political agitation for independence began to emerge in 1956, the Belgians encouraged further polarization by openly supporting the less activist-oriented Lulua. Ultimately, the Lulua-Baluba war erupted on October 11, 1959. A massive flight of the Baluba from Kananga, Dibaya, and other parts of Kasai Occidental occurred. They regrouped in the new "mining province" of South Kasai which declared its separate independence in 1961. Though this move for autonomy was eventually crushed, the Baluba capital of Mbuji Mayi became the regional seat of Kasai Oriental when this Region was created in 1966.

As a result of this conflict, Kananga's population was dramatically altered. The proportion of non-Baluba increased from less than 50,000 in 1960 to over 200,000 in 1974. Thousands of Lulua refugees

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[2]The Baluba Empire was a powerful patrilineal society based on patronage to the chief. It is thought to have dated from the 15th century and only began to lose its predominance in the North Shaba and Kasai area in 1892 when the Belgians penetrated under Kasongo Niembo's reign (Laclavere, p. 26).

from the then successionist province of Katanga settled in Kananga between 1960 and 1962 (Nzongola-Ntalaja, p. 66). In addition, migrants from the countryside, particularly the nearby Zones of Dibaya, Kazumba, Demba, and Dimbelenge, flocked to the city in pursuit of new opportunities for a better life. This led to the spread of squatter settlements both within the city and on the outskirts.

In 1983, the city appeared as a densely populated village, with density estimates ranging from 1000 to 1300 persons per square kilometer. Built on ravines to the east of the Lulua river, Kananga faced severe erosion problems which greatly damaged the foundations of roads and homes, besides polluting the drinking water from sources in the valley floors. Most of the homes in the residential quarters were constructed of non-durable materials, though residents preferred to build small houses with mud bricks and corrugated iron roofs instead of large houses with thatched roofs. Though expensive, the tin roof does not have to be replaced every two years as the grass of the thatched dwelling does.

Kananga's major urban functions were still transportation, commerce and regional administration. Only a small industrial sector existed, consisting of a brewery, a soap factory, and flour mills. Approximately 80% of the city's population were of Lulua origin. The concentration of Baluba in the early 1980s was small, but increasing, especially in the business community. Limited and usually low-paying job opportunities were available in the government or private sector. The resultant levels of high under- and unemployment were rarely alleviated by engaging in crop cultivation near the city due to

the poor productivity of the soil compounded by excessive thievery. Those families who did maintain fields of manioc did so to insure a supply of leaves to eat, as yields of tubers in the exhausted soils were extremely low. A predominant occupation of non-wage earners was petty commerce--whether it was in the form of a roadside stand or transporting foodstuffs from the rural areas.

Dibaya

The population of Dibaya consists almost entirely of tribes belonging to the Lulua ethnic group. Pockets of Baluba found in Tshimbulu, Dibaya, and Lubondayi were driven out during the civil war.

There were three major factors that considerably influenced the social structure in the research area in Dibaya:

1) the proximity of the rail line,

2) the presence of one of the first missions established in Kasai Occidental at Heptienne (now Bunkonde), and

3) the poor soils.

Together the three encouraged substantial emigration from the area during the colonial period. The rail line cutting across the Zone provided access to Lumbumbashi and the opportunity to look for work in the mining sector. The mission provided educational background and often the connections necessary for men to find wage employment elsewhere. Poor soils discouraged agriculture as a livelihood for any educated person. Consequently, a study of agricultural production in the Bunkonde area in 1958 found that 27-30% of all households were headed by women alone (Beguin, p. 91). However, any men or

women remaining in the area could easily sell whatever surplus they might harvest. The proximity of Kananga by road (60-90 kms) meant that trucks frequently came to local markets in search of produce, particularly manioc. In addition, the dissemination of fruit trees occurred along all routes leading to the mission. By the late 1950s, fruit had become a profitable export by train for feeding mine workers in Katanga (Beguin, p. 95).

During colonial times the Zone of Dibaya, along with the Zone of Mweka, were the principal producers of manioc and maize for Kananga. In addition, the presence of an oil-works in Tshimbulu made planting peanuts economically attractive as well. Cotton cultivation was not very profitable, however, and was only grown by farmers subject to the Travaux d'Ordre Educatif (T.O.E.). In spite of its benevolent title, the T.O.E. was an "imposed" cultivation law which affected every able-bodied male who did not have any work other than agriculture. Requirements varied from Territory to Territory.[3] For the area under consideration, each man was required to grow annually 20 ares of cotton and 20 ares of peanuts. According to Beguin (p. 106), a farmer in the Dibaya area subject to T.O.E. cleared 87 ares per year compared to 51 ares for an "exempt" farmer and 38 ares for a woman heading a household alone.

"Imposed Cultivation" disappeared at independence but was reintroduced in June of 1976 in response to the sharp decline in

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[3]The general ordinance released in September, 1935, (No. 137/bis/AIMO) stipulated that every able-bodied villager should cultivate .21 hectares (21 ares) each of manioc, maize, bananas, peanuts, and cotton (Navin (1984)).

agricultural production which had occurred over the preceding 15 years. The requisite crops designated for Kasai Occidental were manioc, maize, peanuts, rice, soya, and cotton. Each farmer was to plant 20 ares of peanuts, 10 ares of soya, and 50 ares of each of the remaining crops; 2.3 hectares in total (Navin, p. 2). Enforcement of the law seemed to vary at different sites visited in 1983. Much depended on the relationship between the village chief and the agronome assigned to the area in question. At times the two collaborated and would tax non-compliant villagers as a means of raising personal revenue. As a case in point, two of the original fish farmers in Kasangaie had migrated out of the area to avoid being fined up to Z250 for the second year in a row. In many other instances, farmers reported paying the local agronome a much smaller fee (Z40-50) for not walking out to their fields to verify that the required amount was in place.

Thus, the agricultural prospects in Dibaya Zone had not altered greatly from colonial times. If anything, they had worsened. The dilapidated mud-stick houses frequently encountered in Dibaya stood in stark contrast to the typical mud-brick construction seen in Luiza. The oil-works at Tshimbulu closed in the 1950s. Cotton cultivation, enforced only in theory, was virtually defunct.[4] Involvement in the marketing of garden vegetables in Kananga appeared to be one of the few positive agricultural signs that had developed over the past 10 years. Otherwise, the Zone of Luiza had overshadowed

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[4]The Department of Agriculture reported that in 1981/82 cotton covered only 600 hectares in the entire Region (World Bank, p. 19).

Dibaya as a supplier of basic agricultural foodstuffs. Production and yield figures for 1981/82 are shown for Dibaya, Luiza and Kananga in Table 6. Though rough estimates at best, they corroborate general observations that the clay soils of Luiza produced higher yields than the sandier soils of Dibaya.

Table 6. Crop Production in 1981/82+

Zone	Area (kms^2)	Crop	Production (tons)	Yields (kg/ha)
Luiza	14,702	manioc	250,000	9,400
		peanuts	16,700	620
		maize	14,110	800
		beans	2,820	400
		rice	1,150	250
		soya	984	330
Dibaya	11,191	manioc	126,300	8,200
		maize	14,300	610
		peanuts	2,450	400
		beans	1,400	300
		rice	990	450
		soya	54	270
Kananga	378	manioc	30,590	8,500
		maize	2,240	800
		peanuts	670	600
		beans	640	420
		rice	215	500

+Department of Agriculture, Government of Zaire, Kananga.

Luiza

Of the three major tribes in the Luiza Zone (Bakete, Balwalwa, and the Basala Mpasu), only the Basala Mpasu were based in the research area. Although the Basalu Mpasu also claim that their ancestors originated from near the source of the Lomami River in the North Shaba region, historically they showed none of the expansionist

tendencies of the Luba and Lunda peoples. The neighboring Balunda to the south had adopted the Luba concept of bulopwe: the sacred right to rule over lineages other than one's own. Much of Basalu Mpasu and Bakete history consists of their resistance to conquest attempts by the Lunda and Tshokwe, and ultimately, domination by the Belgians (Pruitt, pp. 45-54).

Unlike the Baluba with their hierarchical structure, the Basalu Mpasu prided themselves on having a stateless society with no chiefs. "The ideal of family individuality produced an aggressive, self-assertive, combative, suspicious, feuding society which was nevertheless shaped by institutions that provided an overall stability and order by a process of checks and balances" (Pruitt, p. 102). Their reputation for cannibalism engendered fear and respect among outsiders.

In addition, the traditional society was matrilineal, i.e. a man's own sons did not inherit wealth or influence from their father. The complex lineage system was summarized by Pruitt (p. 107) as follows:

> Among the Sala Mpasu all inheritance of goods and sacred roles remained functions of the matrilineage (mupanga: pl. mipanga). Patrifilial influences, however, determined residential pattern. The patrifilial settlement (ikota), therefore, served as the practical, mundane economic and political unit. The matrilineal ideal remained in force to prevent patrifilial structures from becoming stabilized. In this situation the scarce resource of political power was theoretically open to all free men, creating, potentially, a constant tension among competing, ambitious men who had to depend on their own abilities more than on consanguine or affinal kinsmen.

This web of interrelationships began to be altered with the coming of Belgian colonial rule and the subsequent introduction of chiefs.

The village gradually replaced the ikota as the primary settlement pattern. Matrikin were ignored in the issuing of identity cards and on other government records. A system of double descent emerged in which the father concerned himself with his own biological children in addition to his sister's children (Pruitt, p. 178). Children encountered in this study were usually living with their biological parents, unless they were living with uncles who were situated closer to where they were attending school.

Needless to say, the issue of inheritance poses a problem with regard to continuity in the fish culture program. The person who inherits the pond might have little or no knowledge of intensive cultivation techniques. As only one of the initial pond adopters in the Luiza area had died since the project's inception, it is hard to judge what will happen in future cases in the Basalu Mpasu area. However, in this instance, the ponds belonging to the chief of the village who died went to his first cousin on the maternal side. The man in question had no previous knowledge of fish culture and was content to let them revert to an extensive system.[5] The chieftaincy itself fell to another individual, the son of his maternal uncle.

Though the Basalu Mpasu did not emigrate to the cities to the same extent as the Lulua did in colonial times, they ceased to exist in independent isolation. One found men and women who had ventured

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[5]This is not to imply that the farmer would not be willing to learn. On the contrary, on hearing that I was in the area, the cousin had the path to the ponds cleared and the grass on the dikes cut down before any encounter took place.

to Mbuji Mayi or the Tshikapa area in order to engage in trading or diamond digging. Bicycles were a common feature throughout the project area, as they were the most widely available, and certainly the most dependable, means for going short to long distances. Moreover, agricultural prospects for persons remaining in the villages were far superior to those in Dibaya to the north.

C. Description of the Households Participating in the Survey

Before being able to assess the relative influence that fish pond culture has had on family well-being, account must be taken of the differences that exist in each of the three areas under consideration. Moreover, the ability to allocate labor to work on ponds is a function of each household's composition, by age and by sex. The educational level attained by both men and women is a significant indicator of well-being in that a very high value is placed on obtaining education by the farmers themselves. In addition, knowledge of the educational status of various members of the household might serve as a useful guideline in the future development of appropriate written and audio-visual extension materials.

Ideally, one should compare the same set of households before and after they adopted pond culture. As no baseline studies existed, it was necessary to concentrate on how fish culture had been integrated into the overall functioning of the household. Broad contrasts in the agronomic value of the land in each area have already been mentioned. An evaluation of any change in nutritional status would also have been highly desirable, but consumption data are extremely

expensive to collect. Information concerning possessions and other general indicators of well-being was gathered by questioning farmers indirectly or through personal observation.

Household Composition

The households included in this survey were broken down into several categories before being analyzed. In instances where there were significant differences between the responses given by initial adopters and other fish farmers, information for the initial adopters is presented separately. Replies from secondary adopters and drop-outs in the rural areas were often combined due to the small sample size of each of these groups and the fact that all but one of the drop-outs interviewed had previously been secondary adopters. When categorical variations were not great, all initial adopters (I), secondary adopters (S), and drop-outs (D) were combined into one "pond-owning" category for each particular zone. Non-participant data (N) were complete for both rural areas, but not for Kananga due to the use of a shortened version of the questionnaire.

The average number of persons living on a parcelle[6] did not vary much among the different areas for pond-owning households (I+S+D). The average ranged from 8.5 to 10.5 persons per household. The mean for non-participant households was lower in all three research areas, from 6.0 to 7.0 persons per household.

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[6]Parcelle is literally translated as the home owner's lot. It will be used in this paper to emphasize the distinction to be made between a household and the actual land, since more than one household can be found living on a single parcelle.

The main features describing the overall structure of the survey households are shown in the following table:

Table 7. Characteristics of the Household Structure

Category	Total Number of: Households	Persons on the Parcelle (mean)	Years on the Parcelle (median)	Age of the head of household (mean)	No. of wives per male heads of households (mean)
Luiza					
I+S+D	17	10.5	12	42.4	1.4
N	12	6.0	7	39.0	1.0
Dibaya					
I+S+D	27	9.3	20	48.5	1.2
N	4	7.0	2	43.3	0.8
Kananga					
I+S+D	72	9.3[7]	18	48.0	1.0
N	21	6.0	5	39.5	1.0

Median values were included for the total number of years on the parcelle as several of the means were biased due to one particularly high or low data point. The averages for this statistic in all three areas were significantly lower for the non-participant sample than for the pond-owning households. The median years on the parcelle for the latter ranged from 12 to 20 versus 2 to 10 for the non-participant households.

The differences noted between the pond-owning and non-participant groups may be a reflection of the younger average age of the non-participants found in this survey. Initial adopters

[7]This figure is somewhat higher than the 7.3 persons per parcelle recorded for Kananga in the 1974 survey (I.N.S., p. 34).

of fish pond culture were generally in their mid-forties to late fifties. It is not unreasonable to speculate that they probably had access to better land than did the non-participants as they were older and had been established in the area for a longer period of time. In addition, the greater number of persons living on their parcelle could be indicative of a larger labor pool to draw on for constructing and managing the ponds. The highest incidence of polygamy in all categories was found among households in the Luiza Zone.

The breakdown of household composition by age and sex reflected the nature of the available labor pool for fish pond culture. The division of household members by sex is shown in Table 8:

Table 8. Sex Composition of Survey Households

	Percent of Household Members:					
	LUIZA		DIBAYA		KANANGA	
SEX	I+S+D	N	I+S+D	N	I+S+D	N
Female	55	54	52	57	47	49
Male	45	46	48	43	53	51

A higher proportion of females to males was reported in all Luiza households, and in the Dibaya households as well, excluding the initial adopters (47 vs. 52%). The opposite was true among urban families, with the male members of the household in Kananga outnumbering the females. Though a striking imbalance favoring males in the sex ratio is the norm in most African cities, it has not always been so in Kananga. Belgian colonial policy had encouraged men to bring their wives and children to the city in an attempt to increase

the likelihood of permanent residence, thereby establishing a stable workforce. Near equality was found in the sex composition ratio of Kananga before and after independence. There was even an excess of women over men reported after independence. The 1974 survey calculated that males made up 50.07% of the city's population, females 49.93% (I.N.S., p. 35). In any case, the regional character of the city made it easier for men to immigrate with their families at the outset (Nzongola-Ntalaja, p. 93).

As was expected, the household composition was dominated by youths. Major age divisions among the survey households were as follows:

Table 9. Age Composition in Participant Households

Household Members having Age of: (in years)	<15		16-30		31-49		>50	
	% of Total	No. per house-hold	% of Total	No. per house-hold	% of Total	No. per house-hold	% of Total	No. per house-hold
Luiza								
I+S+D	49	5.1	30	3.2	12	1.3	8	0.9
N	44	2.5	26	1.4	15	0.8	15	0.8
Dibaya								
I+S+D	49	4.5	26	2.4	12	1.1	12	1.1
N	54	1.4	22	1.2	11	0.8	14	1.0
Kananga								
I+S+D	54	4.8	24	2.4	15	1.4	7	0.6

Level of Education Among Household Members

The opportunity to attend school at least for a short period of time during their life was fairly high for younger male members of households in all of the areas investigated. Female members living in the rural areas were at a distinct disadvantage to their urban counterparts (for a complete breakdown by age group and zone see Appendix B). The percent of women who had studied at all was much higher among those less than thirty years old than among those who were older. The lower percentages of girls compared to boys in the 6 through 10 year old age group in the rural areas was probably due to a longer delay in beginning primary school studies. Differences in the average age of children covered by the survey that were currently enrolled in school is recorded in Table 10.

Table 10. Average Ages of Children Currently Attending School

	Luiza		Dibaya		Kananga	
Enrolled in:	Male	Female	Male	Female	Male	Female
1st Year Primary	7.4	9.0	8.4	8.7	7.2	6.5
1st Year Secondary	12.7	15.5	14.9	17.0	15.0	14.4

Clearly, girls in the urban area had much better access to educational facilities. Inequalities between the sexes in the education received were also reflected in the ultimate level of schooling obtained. (For a table showing the mean number of years of study attained by males and females in each age group refer to Appendix B.) Rural women rarely went

beyond primary school; rural men rarely finished secondary school.[8] The average number of years studied is highest for all age groups in Kananga.

The majority of the principal fish farmers in this survey were also the male heads of the households. There were instances, however, in which a woman or the son of the head of the household was in charge of the ponds. The major characteristics of the 116 fish farmers interviewed are given in the following table:

Table 11. General Characteristics of Principal Fish Farmers

Category	Age	Percent of Farmers that are Female	Number of Years Farmer Studied (Mean)
Luiza			
I	44.5	0	5.9 (2.1)[a]
S+D	35.8	0	5.8 (1.7)
Dibaya			
I	54.5	0	4.8 (1.9)
S+D	38.9	8.3	5.4 (2.9)
Kananga			
I	46.7	0	8.8 (3.2)
S+D	42.5	10.0	7.4 (3.3)

[a]Number in parentheses is the standard deviation of the mean.

Most fish farmers in Kananga had obtained some secondary schooling. The age of secondary adopters and drop-outs in the city was higher because the vast majority of younger secondary adopters who abandoned their ponds left the area.

[8]Older women (>50 years of age) in the Luiza households were unable to converse in Tshiluba because none of them had attended primary school where it was taught. French, on the other hand, was not introduced until secondary school.

Measures of Well-Being

Table 12 summarizes various criteria chosen to illustrate relative well-being among households participating in this study. The most important of these is the category of self-sufficiency in manioc and maize production. Luiza had the highest percentage of households, among both the pond-owning and non-participant groups, that never had to buy any manioc or maize. All was produced in their own fields. Only 4% of all the households in Luiza had to purchase all of their manioc, and all of these were non-participant households. As might be expected, residents in the urban sector were at the opposite extreme. Ninety-two percent of all pond-owning households had to purchase all of their manioc. Ninety-six percent of them had to purchase all of their maize. Families in Kananga that were self-sufficient in manioc and maize production only accounted for 6 and 3% of all the pond-owning households. In Dibaya, as in Luiza, all of the households had fields. However, a substantial portion of the Dibaya sample had to buy some manioc and maize to supplement what they raised (23 and 40%, respectively, for all households). Seventeen percent of all Dibaya households had to purchase all of their manioc, 13% all of their maize.

A tin roof represents a substantial investment of the part of the resident, but it does not necessarily reflect the condition of the house itself. Approximately 10% of the homes in both Luiza and Dibaya had tin roofs compared to 88% for homes among pond-owning farmers in Kananga. Urban residents had access to new tin roofing on an irregular basis, but its high cost meant that used roofing

Table 12. Measures of Well-Being Among Survey Households

(Percent of Total Number of Households Surveyed)

INDICATOR	LUIZA I	LUIZA S+D	LUIZA N	DIBAYA I	DIBAYA S+D	DIBAYA N	KANANGA I	KANANGA S+D	KANANGA N
No. Households in Each Category	13	4	12	15	12	4	18	54	21
SELF-SUFFICIENT in MANIOC:									
All from fields	69	100	83	47	91	25	0	7	+
All Purchased	0	0	17	13	9	50	94	91	+
SELF-SUFFICIENT in MAIZE:									
All from fields	77	100	100	40	64	25	0	4	+
All Purchased	0	0	0	0	9	50	94	94	+
HOMES HAVING:									
Tin roofs	8	25	8	20	0	0	78	91	+
Wooden Windows	85	75	42	65	25	0	83	65	+
OWNING:									
Radios:									
Working	62	75	25	47	42	50	44	46	71
Broken	0	0	8	0	0	0	11	7	0
Bicycles:									
Working	46	75	33	40	17	25	39	17	19
Broken	8	0	0	7	25	0	6	2	0
SOURCE OF FUEL:									
Wood Only	92	75	100	87	100	100	39	18	+
Charcoal Only	0	0	0	0	0	0	17	15	+
Wood + Some Charcoal	8	25	0	13	0	0	44	67	+
SOURCE OF WATER:									
In valley	100	100	100	100	100	100	33	20	+
Pipe on parcelle	0	0	0	0	0	0	44	43	+
Pipe in quarter	0	0	0	0	0	0	17	35	+
Pipe & in valley	0	0	0	0	0	0	6	2	+

+ Data not obtained

was in high demand. A much higher percentage of Luiza households had wooden windows than did the rural homes in Dibaya (66 versus 42%). The superior construction and maintenance of homes in Luiza as compared to those in Dibaya has already been mentioned. Although wood was dear in the urban area, 69% of all pond-owning households and 83% of all initial adopting households had wooden windows. Most of the European style homes built in housing tracts for workers during the 1950s had tin roofs, wooden windows, and cement brick walls. Several of the initial adopters lived in such mass complexes built in Nganza, Katoka, and Ndesha.

The extent of radio ownership is of particular interest as the radio is the major source for obtaining information from Kinshasa or other countries. While the regional station in Kananga was not functioning in 1983, most radio owners could receive transmissions from Kinshasa, Mbuji Mayi, and occasionally, Lubumbashi. The highest proportion of ownership was found among non-participant households in Kananga (71%); the lowest among non-participant households in Luiza (33%). Among pond-owning households, families in Luiza had the highest percentage of working radios (65%). The fact that a radio could function, however, did not mean that it was constantly in use. Extensive listening was prohibited in most households by the high price and short life-span of locally available batteries.

Bicycle ownership among both pond-owning and non-participants in Luiza was significantly higher than that found in Kananga, in spite of the fact that Luiza residents were much farther away from the regional center where bicycles are primarily sold. The bicycle

is an essential item for small-scale marketing in Luiza, especially due to the lack of a rail line and limited truck traffic passing through the Zone. Overall, 48% of the Luiza households possessed one bicycle in working order; an additional 3% had broken ones. Forty-one percent of the families in Dibaya also owned bicycles, but only 29% of them had one in usable shape. This is not to say that bicycles are not desired in the urban area, just that their cost is beyond the reach of most people.[9]

Families in both rural areas still rely principally on wood as fuel for cooking. Less than ten percent of the households in Luiza and Dibaya utilized some charcoal in cooking. Selling of charcoal was a common sight along the main road from Tshimbulu to Kananga. All types of energy-obtaining materials in Kananga--wood and charcoal for cooking, kerosene and candles for light, diesel and gasoline for transport--were expensive. Wood, charcoal, and kerosene were commonly sold in small quantities throughout the residential quarters. Of the pond-owning households in Kananga,

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[9]In his 1974 analysis of urban administration in Kananga, Nzongola-Ntalaja (p. 236) provided what in retrospect is a rather ironic insight: "As strange as it might appear on the surface, only a very small proportion of city employees used bicycles as a means of transportation. Once a symbol of prosperity, the bicycle has lost its prestige value in Zaire. Its place has been taken over by the motorbike, whose acquisition requires an investment far above the means of an ordinary clerk, with a price range of Z40 and up for used ones, and of Z70 to over Z100 for new ones. Because of the deep penetration of the values of conspicuous consumption of the <u>nouveaux riches</u> even among the dominated classes of Zairian society, most lower civil servants would prefer walking to riding the now discredited simple bicycle." Obviously, conditions had worsened to the point where the beleaguered bicycle had regained some of its status.

24% rely on wood only as a cooking fuel; 15% rely on charcoal only; 61% utilize both.

All of the households in Dibaya and Luiza collected their drinking water from springs in nearby valleys. In a few instances in Dibaya, spring boxes with pipes had been installed--the result of a water improvement program by PROPA.[10] Approximately one-quarter of the pond-owning urban households still had to descend into the valleys in search of drinking water. However, conditions had improved considerably for urban residents over the past year as a water system was in the process of being installed at the same time this research was in progress. Focal points for public faucets existed in each of the five Zones making up the city by the end of 1983. The cost of installation of a tap on one's own parcelle was steep-- Z2000 to Z2500, followed by a monthly charge of Z50.

Other Animals Owned

As can be seen in Table 13, many different kinds of animals are owned by residents in all three areas. In terms of percent of households owning a particular animal, the Luiza zone dominates in most categories. It was the only sample in which households were found that possessed cattle. Significantly higher values for pig and sheep ownership were also found in Luiza. Previous to 1983, pigs were a very common sight in the Dibaya zone as well. The fact that only 3% of the households in the Dibaya research area had pigs is due to the implementation of a local ordinance during the past year banning pigs because of their excessive destruction of crops.

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[10]Promotion du Paysan, the Catholic Development Agency in the Zone.

Table 13. Measures of Well-being: Other Animals Owned

ANIMAL	LUIZA				DIBAYA				KANANGA			
	% owning[a]		Total Number[b]		% owning		Total Number		% owning		Total Number	
	I+S+D	N	I+S+D	N	I+S+D	N	I+S+D	N	I+S+D	N	I+S+D	N
Cow	35	0	0.9	0	0	0	0	0	0	+	0	+
Goat	82	33	3.8	3.3	67	100	2.6	3.3	40	+	1.6	+
Pig	35	25	1.4	1.1	4	0	0.1	0	4	+	0.2	+
Sheep	36	25	1.1	2.6	4	0	0.1	0	3	+	0.2	+
Duck	35	17	1.6	1.7	11	0	1.0	0	26	+	1.2	+
Guinea Fowl	12	0	0.4	0	22	0	0.7	0	11	+	0.5	+
Chicken	82	67	7.7	4.2	85	100	6.8	3.3	49	+	2.9	+
Rabbit	18	8	1.1	1.7	44	25	2.5	3.0	6	+	0.3	+
Pigeon	12	8	0.6	0.2	8	0	1.2	0	6	+	2.5	+
Guinea Pig	59	50	5.9	4.1	63	50	4.7	4.3	17	+	0.9	+

[a]Percent of total number of households surveyed that owned each animal.

[b]Number of animals owned per household.

+Data not obtained.

The most commonly encountered animals on the parcelle were goats and chickens. Both are highly preferred meats primarily eaten on special occasions or used to pay debts. Goats are the most significant component of the bride price in Luiza. It was reported that the number of goats needed to marry a Basala Mpasu woman in 1983 ranged from 18 to 30. With the cost of a goat at that time ranging from Z800 to Z1000, marriage by men was considerably delayed unless they were willing to take a wife from another tribe. In contrast, one secondary adopter in Dibaya reported that he had taken a second wife in July of 1983 by providing her family with two goats (one male, one female), Z2500, three pieces of fabric (6 yards in length), three headscarves, and gunpowder. The farmer in question had recently returned from spending two years engaging in trading manioc between Mweka and Kananga to raise the money.

Though popular, chickens are notoriously susceptible to disease. Half of the pond-owning households stated that they fed their chickens on a regular basis. Rabbits and guinea pigs, which were usually kept inside of the house, were the only animals fed all of the time in all of the research areas. A breakdown of the percentage of animal-owning households that feed, and who did the feeding is shown in Table 14. In general, feeding was not usually a specifically designated task for one individual, but was more of a haphazard process done by various family members. For the vast majority of farmers in the survey, fish culture was their first introduction to the concept of intensively feeding an animal. Only a few cases of any attempts at intensive management of other forms of husbandry

Table 14. Care of Animals in Survey Households

	LUIZA			DIBAYA			KANANGA	
	Percent of Animal-owning Households That Do Feed		Feeding Primarily Done By:[a]	Percent of Animal-owning Households That Do Feed		Feeding Primarily Done By:	Percent of Animal-owning Households That Do Feed	Feeding Primarily Done By:[b]
	I+S+O	N		I+S+O	N		I+S+O	
Cow[c]			Hired Labor					
Goat	29	0	Whole Family (100)	17	33	Whole Family, (40) Male Heads Alone, (20) Male Head & wife, (20)	10	Whole Family, (33) Female Head & Children (33) Children Only, (33)
Pig	83	67	Whole Family, (86) Male Head & 2 Wives (14)	100	—	Whole Family, (100)	100	Whole Family, (100)
Sheep	0	0		100	—	Whole Family, (100)	0	—
Duck	83	—	Whole Family, (60) Male Head & 1 son, (20) Younger Brother & Male Head, (20)	100	—	Whole Family, (100)	47	Whole Family, (56) Male Head Alone, (33)
Guinea Fowl	100	—	Whole Family, (100)	100	—	Whole Family, (83) Male and 1 Wife, (17)	62	Whole Family, (40) Male Head Alone, (40)
Chicken	50	50	Whole Family, (46) Male Head Alone, (27)	52	75	Whole Family, (40) Male & 1 Wife, (27)	23	Whole Family, (62) Male Head Alone, (38)
Rabbit	100	100	Whole Family, (50) Younger Brother of Male Head, (25) Male & 2 Wives, (25)	100	100	Whole Family, (85)	100	Male Head & Children (75) Children Only (25)
Pigeon			Whole Family, (50) Male Head & Son (50)	67	—	Whole Family, (67) Male Head & 1 Wife (33)	57	Whole Family, (57) Male Head Alone, (29)
Guinea Pig	100	100	Whole Family, (56) Male Head (19)	100	100	Whole Family, (71) Male & 1 Wife, (17) Male Head & Children (12)	100	Whole Family, (67) Male Head & Children (25) Female Head Alone, (8)

[a]Includes both pond and non-pond owners.

[b]Does not include non-participants.

[c]Cattle belonging to many individuals are placed in a single herd and a monthly fee is paid to the herdsman.

were encountered, and most of those were due to having worked with a P.P.F. extension agent. The most advantageous aspect of raising fish as opposed to other animals was the disease resistance exhibited by tilapia.

In terms of overall well-being, the Basala Mpasu in the parts of Luiza surveyed were found to have houses in the best condition, the most fertile land, the highest proportion of families owning bicycles, and the highest percentage of households possessing the most valuable forms of livestock, including cattle. The only real apparent benefit to living in the inflation-ridden city was access to better educational facilities, especially for girls. The quality of existence in Dibaya falls somewhere in between--fewer households are self-sufficient in manioc and maize production than in Luiza, but proximity to Kananga simplifies marketing of crops or engaging in small-scale trading.

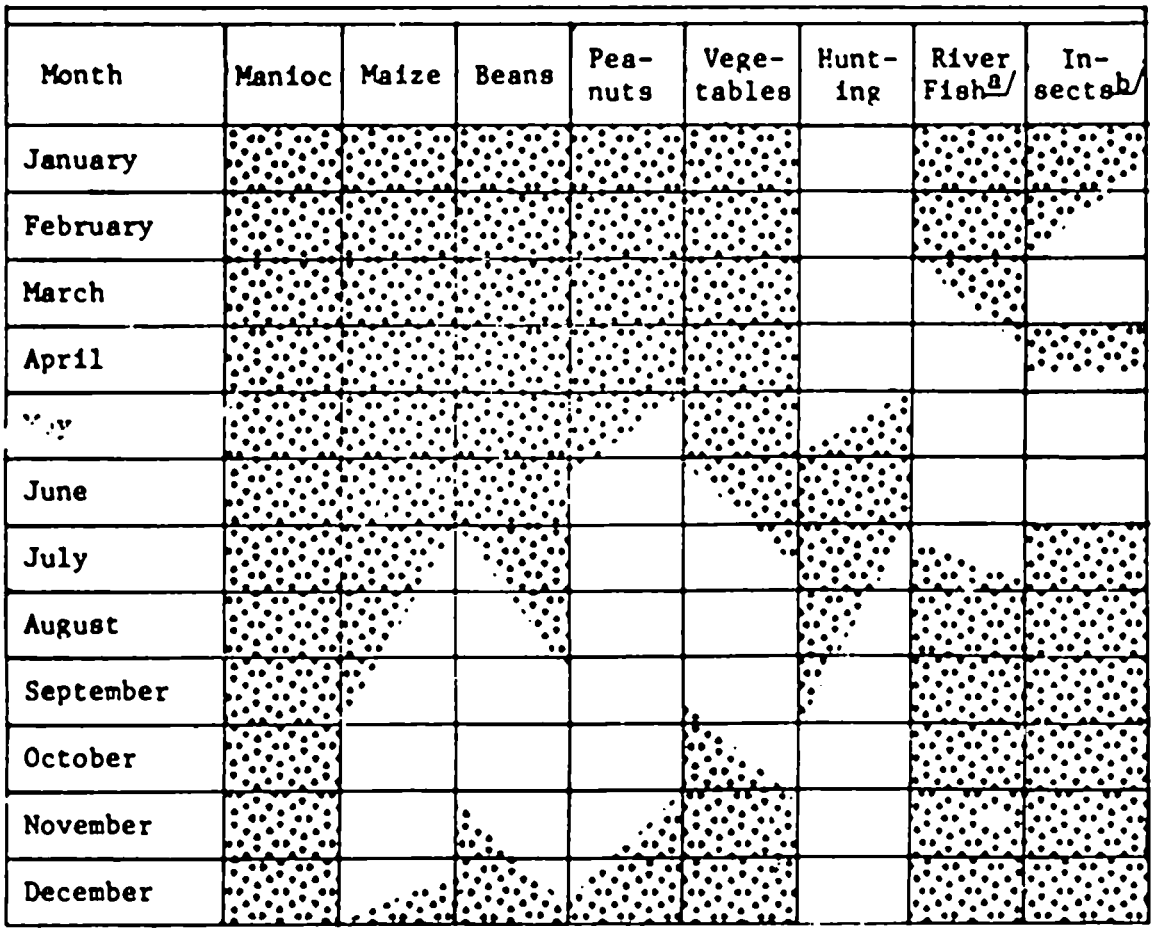
V. THE SOCIO-ECONOMIC ROLE OF FISH POND CULTURE IN PARTICIPANT HOUSEHOLDS

A. The Benefits

The assessment of the fish culture project's impact must be approached from two vantage points: its significance as a subsistence activity helping to provide greater food security within the home and its usefulness as an additional means of generating income for the household. The majority of all farmers interviewed (68%) cited the desire to feed their family as their primary reason for engaging in fish pond culture. Only twelve per cent stated that they undertook raising tilapia in order to make extra money. However, the ability to earn cash from the ponds was considered to be the second most important reason for having ponds among 45% of the farmers in the survey. Thus, it is important to evaluate not only the income earned from fish culture, but the extent of home consumption as well.

In areas possessing a constant water supply, pond culture was highly complementary to manioc production. The fresh tilapia served as a year-round source of animal protein to balance the predominantly carbohydrate diet during those times of the year when the supply of alternate sources of protein diminished. Approximate periods of food product availability for the Lulua Sub-Region are shown in Figure 3. As might be expected, the most critical period of adequate basic foodstuff availability began in the dry season (May-August). From mid-July through mid- to late December, prices of the three most important sources of vegetable protein (maize,

FIGURE 3. YEAR-ROUND AVAILABILITY OF FOOD PRODUCTS IN THE LULUA SUB-REGION*



Period when product is generally available

Period when product is generally not available

*Adapted from D'Heer, Angèle, "L'alimentations de la Region de Luluabourg" (Ecole Supérieure de Gradués en Diététique), 1964-65.

a/ Excludes the trapping of eels, whose peak period falls in April and May.

b/ Termites, caterpillars.

beans, and peanuts) began to rise as their supply decreased. In the Mazala-Tulume area of Luiza, for example, two sticks of maize sold for 1 zaire (Z) in August 1983; by November 1983 only one stick could be purchased for Z1. The price for manioc likewise doubled: 10 sticks for Z10 in August became 5 for Z10 by November.[1] In addition, many sources of bisekiseki (leaves) available during the rainy season became depleted during the dry season. Though hunting for game was most popular during the dry season when fields could be easily burned, prices for wild game were equivalent to other types of meat which sold for up to twice as much as fresh fish per kilogram. By the late dry season, river fish became more plentiful in Luiza and Dibaya and were affordable by a large percentage of the households in those two areas.

One of the most popular times for harvesting fish was during the dry season since there was no rain to impede the harvesting and marketing process. The fact that the harvest date could be flexibly adjusted to meet critical income needs enhanced the overall value of the ponds. For example, payment of initial school fees for the year fell at the end of the dry season in September, a time when the cash resources in the family had often already been spent on food. Increased home consumption of pond fish also occurred around holiday times, whenever guests came to visit, and in the month or so just before major crop harvest periods when cash within the family was in short supply.

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[1]Though the trend for increasing prices during this time period is a general one, the magnitude of the increase in 1983 was enhanced by the devaluation in September.

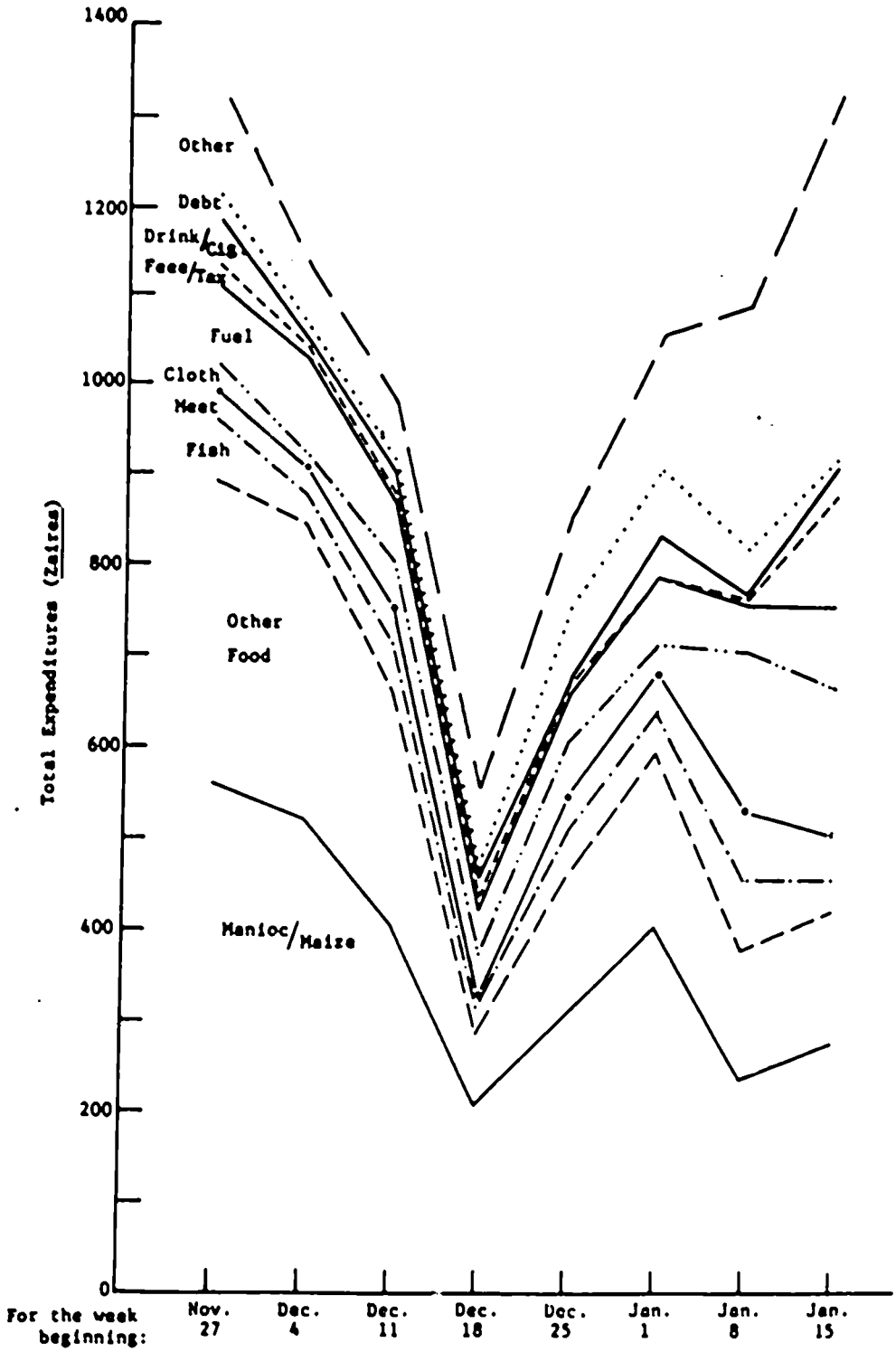
The subsistence nature of existence in Kasai Occidental was reflected in how farmers disposed of the cash earned from harvesting their ponds. Information was gathered on how money from each household's most recent harvest was spent and is summarized below in descending order of importance:

LUIZA	DIBAYA	KANANGA
Buy clothes	Buy other animals	Buy manioc & maize
Pay school fees	Buy clothes	Pay school fees
Buy soap &/or salt	Pay school fees	Buy other food &/or drink
Buy other food &/or drink	Buy other food &/or drink	Buy clothes
Buy other animals	Buy soap &/or salt	Buy soap or salt
Buy manioc &/or maize	Buy manioc &/or maize	Buy other animals

In all three areas, income generated from the ponds was used to help meet the basic needs of the household. Manioc and maize dominated purchases in the urban sector, while rural expenditures were focused on buying articles that were imported from the city (clothes, soap, and salt), school fees, or investing the money by buying other kinds of animals. Other uses included paying off a debt, obtaining medical care, and purchasing fish food. No expenditures on such luxury items as radios and bicycles were reported.

The predominant role that the purchase of basic food staples played in urban area household expenditures is illustrated by the data collected from nine Kananga households. The average weekly expenditures and their apportionment for a two-month period among various goods and services is shown in Figure 4. Some distinct differences were seen in the way in which money was spent in the first month (November 27th through December 24th) versus the second

FIGURE 4. AVERAGE WEEKLY EXPENDITURES OF NINE INITIAL ADOPTER HOUSEHOLDS IN KANANGA, 1983/84



month (December 25th through January 22nd). This is because the latter encompassed two major holiday periods (Christmas and New Year's), as well as the payment of the second portion of yearly school fees in mid-January. A substantial decline in average spending occurred in the week previous to the onset of holiday time, then rose again. The percentage allocation among major expenditure categories is summarized in the following table:

Table 15. Allocation of Household Expenditures by Nine Initial Adopter Households in Kananga 1983-1984 (Percent of Total Expenditure for All Households)

USES	First Month (Nov. 27-Dec. 24)	Second Month (Dec. 25-Jan. 22)
Manioc and/or Maize	42.2	28.2
Fish	4.8	4.6
Meat	2.8	4.5
Other Food	24.6	14.7
Cloth/Clothing	3.4	10.1
Fuel	7.8	5.7
Taxes, School Fees	1.1	2.4
Pay Debts	1.9	4.1
Drinks, Cigarettes	2.6	2.0
Other	8.7	23.6

Purchases of manioc and maize accounted for the highest proportion of income in both months, although its relative importance in the second month declined. As one might expect, expenditures on meat

and cloth increased significantly at holiday time. The Other category included all household items (such as basins, plates, beds, soap) as well as medication, repairing the home, and outlays for funerals. The marked increase in the Other category in the second month is in large part due to the death of one of the farmers during this time.

Average Quantity and Size of Ponds Constructed

The amount of potential fish production depended to a certain extent on whether or not the farmer had participated under the supervision of an extension agent. While it is difficult to draw a generalized portrait of a "typical" fish farmer, the statistics presented in Table 16 provide an accurate reflection of the major differences found concerning the average quantity and size of ponds built by initial and secondary adopters.

In the rural areas, the average number of ares owned by secondary adopters was less than half that found among initial adopters. Likewise, the average size of the largest pond owned by a secondary adopter was under one are, the recommended minimum size advocated by the extension service. All of the secondary adopters in Luiza who continued to raise fish had received some limited extension contact. The same group in Dibaya had no extension contact. The size and quantity of ponds owned by drop-outs in the Dibaya zone were not significantly different from those secondary adopters who had not abandoned their ponds. The mean number of ares per pond

TABLE 16. AVERAGE QUANTITY AND SIZE OF PONDS

	Number	Percent Having Fields Next to Ponds	Total: Number of Ponds	Total: Area (ares)	Average: Ponds per Farmer	Average: Ares per Farmer	Average: Ares per Pond	Average: Size of Largest Pond (ares)
INITIAL ADOPTERS								
Luiza*	15	62	78	129.2	5.2	8.6	1.6	2.4
Dibaya*	18	40	68	84.0	3.8	4.7	1.2	2.3
Kananga	18	78	134	282.3	7.4	15.6	2.1	4.4
SECONDARY ADOPTERS								
Luiza: Continued	3	33	9	5.6	3.3	2.1	0.6	0.76
Abandoned	0							
Dibaya: Continued	7	43	18	12.0	2.6	1.7	0.7	0.93
Abandoned	5	80	10	7.5	2.0	1.5	0.8	0.78
Kananga: Continued	34	9	186	266.8	5.5	7.9	1.4	2.27
Abandoned	20	5	73	94.6	3.7	4.7	1.3	1.82

*These numbers are different from the number of farmers interviewed for the zones of Luiza and Dibaya as they include pond measurements for all initial adopters whose ponds were visited in the Luiza zone--one of the farmers had abandoned his ponds, another had died but the ponds were still in production. The farmers in Dibaya had left the area permanently but their ponds were being looked after by relatives, albeit extensively.

possessed by an initial adopter ranged from 1.2 to 1.6 ares, with the average size of the largest pond being 2.35 ares.

There was a significant difference between the average number of ponds and ares per farmer in the urban and rural areas. Initial adopters in Kananga had 7.4 ponds per person; those in Luiza 5.2 ponds; and those in Dibaya 3.8 ponds per person. Initial adopters in Kananga had twice as many ares per farmer as did secondary adopters. This is partly a function of having claimed the best and most extensive sites in the city before competition for land on the valley floors became so intense. In addition, those secondary urban adopters who h d received limited extension contact (53% of those interviewed) owned an average of 9.4 ares compared to a mean 6.1 ares per individual who had not ever talked to an agent.

The average secondary adopter in Dibaya with well-managed ponds should have been able to produce 51 to 68 kgs. per year (1.7 ares X 30 to 40 k/are/year), whereas the initial adopter had the capacity to raise as much as 141 to 188 kilograms. It is doubtful whether any secondary adopter ever achieved those levels of production, having had little or no extension contact. Natural production alone would produce 4 to 6.8 kilograms per year and with limited regular feeding, up to 27 kgs/are/year. Actual yield figures for secondary adopters fell in between these two limits. Even if the initial adopter only fed on a limited regular basis, output would have been two to three times that produced by the secondary adopter due to the greater area under production.

Comparison of Fish Culture versus Other Income-Generating Activities

It is a challenge to assess the relative economic contribution of pond culture versus other endeavors because many of the income-earning activities of a household fall outside of the economic endeavors monitored by normal techniques. The increasing dominance of the second economy in Zaire means that official statistics regarding wage rates and the like bear very little relation to reality. The situation is aptly described in the commonly heard response to questions on how one could live on so little: "Il faut se debrouiller" (One learns to get by). MacGaffey (p. 361) cited a 1976 study of sources of income in 500 households from the urban core of Kananga which provides some figures on how urban dwellers supplement their official salaries: Formal sector salaries accounted for 42% of total household income; trade 20.8%; and cash or in-kind transfers from outside the household or food produced within the household 36%. Over 50% of the households earned some income from trade.

Most of the rural inhabitants in this study were self-employed and comparisons could only be drawn between income earned from the most recent harvests of crops and fish. In the urban sector, it was necessary to try to identify discrepancies between figures on wages and prices and actual expenditures.

As was stated previously, the importance of fish culture as a source of income generation depends on the general well-being of the residents in each area. The project was aimed at male members of a household who were considered to be under-employed at certain times of the year, if not year-round. Most rural households were

engaged in numerous subsistence activities, and readily accepted the idea of adding a new activity. In the urban environment, opportunities to become involved in such activities as crop and palm oil production were limited and consequently, additional means of earning income were eagerly sought.

Each household was asked to list their five most important income generating activities in order of descending importance. Responses were aggregated for both initial and secondary adopters in order to have a picture of the relative role fish culture was playing as a source of income generation in 1983. The results are presented in Table 17. Crop production was only considered as an income generating activity if crops were sold from the family's fields. Overall, fish culture had become one of the top three income earning activities in 63% of the households surveyed in Luiza, 50% of those in Dibaya, and 64% of those in Kananga. The remaining families listed pond culture as their fourth or fifth most important income generating activity or did not include it at all because all of the fish produced were consumed at home. The majority of the latter were secondary adopters who owned fewer ares and produced much smaller quantities of fish than the initial adopters.

Fish ponds played a much more significant role in generating income in the zones of Dibaya and Kananga than in the relatively prosperous zone of Luiza. Forty-eight per cent of all pond-operating households in Kananga, and 23% of those in Dibaya had only two significant sources of income. The lack of alternatives for the urban dweller to earn money is reflected in Table 18, which lists

TABLE 17. RELATIVE IMPORTANCE OF INCOME GENERATING ACTIVITIES AMONG HOUSEHOLDS WITH PONDS IN PRODUCTION IN 1983

(Percentage of all initial and secondary adopters interviewed)

	LUIZA		DIBAYA		KANANGA	
	Activity	Percent	Activity	Percent	Activity	Percent
PRIMARY Income Generating Activity	Crop Production	75	Crop Production	41	Trading	29
	FISH PONDS	6	Gardens	14	Teaching	21
	Palm Wine	6	Palm Oil	14	FISH PONDS	12
	Palm Oil	6	Selling Animals	14	Government Worker	8
	Trapping Eels	5			Crop Production	6
			Other: Trading, Selling Fruit, Coffee, Palm Wine		Diamond Digging	4
					Mason	4
SECOND Most Important Activity	Trading	19	FISH PONDS	36	FISH PONDS	31
	FISH PONDS	19	Crop Production	14	Trading	19
	Crop Production	13	Alcohol (Cinq centers)	14	Teaching	12
	Palm Wine	13			Selling Animals	10
			Other: Gardens, Selling Animals, Coffee, Mason, Diamond Digging, Repairing Basins		Crop Production	8
	Other: Fishing, Hunting, Nursing, Selling Animals, Palm Oil				Government Worker	6
					Nursing	4
					Pension	4
THIRD Most Important Activity	FISH PONDS	38	Selling Other Animals	23	No Third Source	44
	Trading	13	No Third Source	23	FISH PONDS	21
	Palm Wine	13	FISH PONDS	14	Trading	12
	Selling Animals	13	Trading	14	Selling Other Animals	8
	No Third Source	12	Gardens	9	Government Worker	6
FOURTH Most Important Activity	No Fourth Source	56	No Fourth Source	46	No Fourth Source	85
	Selling Animals	19	FISH PONDS	18	FISH PONDS	6
	Palm Oil	12	Selling Animals	9		
			Hunting	9		

the principal income generating activities remaining to farmers who had abandoned their ponds.

Table 18. Relative Importance of Income Generating Activities in Drop-out Households

(Percent of All Drop-out Households Interviewed)

	RURAL SECTOR		URBAN SECTOR	
PRIMARY Activity	Crop Production	43	Trading	40
	Trading	43	Government Worker	20
			Crop Production	10
	Other:		Non-government	
	Blacksmith	7	Salaried work	10
			Teaching	5
			Other[a]	15
SECOND MOST Important Activity	Diverse+: Pot-making, Crop Production, Pension, Gardens, Selling other animals, Rope-making, Palm oil		No Second Source	50
			Trading	15
			Crop Production	10
			Teaching	5
			Other[a]	20
THIRD MOST Important Activity	Gardens	28	No Third Source	95
	Selling Other Animals	28	Other	5
	Other[a]	44		

[a]Each individual activity made up less than 7% of total.

Fifty percent of the urban residents who abandoned their ponds had no second source of income, and 95% of them lacked a third. They had to rely primarily on small-scale trading as a cash source, unlike rural drop-outs who could still count on their fields to provide both food and cash. The initial and secondary adopters in Kananga often turned to their ponds as an emergency source of cash. Forty-six percent of those interviewed had to harvest a pond at least once before the end of the recommended six month production period was

reached to obtain cash for purchasing manioc and maize or to pay school fees. In contrast, farmers in Luiza would rarely harvest before six months. In fact, the tendency was to wait longer (from seven to eighteen months), especially if the harvesting schedule conflicted with peak labor demand periods in the fields.

In the Luiza area, 88% of the pond-operating (I+S) households in 1983 had fields from which some production was sold, as did 86% of the Dibaya households and only 21% of the Kananga families. Thirty-nine percent of the pond-operating households in Kananga had no fields at all. The average earnings obtained from the three most significant crops sold by each farmer are summarized in Table 19. Luiza initial and secondary adopters made approximately 3.5 times more from the sale of their most important crops than did those in Dibaya or Kananga. The values presented in Table 19 are probably underestimates as recall ability on the total amount of manioc sold during the year was poor among most households. This is because manioc, unlike peanuts and maize, was frequently sold in small quantities on an irregular basis, particularly in the Zone of Dibaya.

Table 19. Income Generating Crop Production in Pond-Operating and Non-Participant Households (1983)

AREA	Percent of Households That Sold Crops From Their Fields	RELATIVE IMPORTANCE OF PRIMARY CROPS (In descending order of importance as one of top 3 income earners)	Total Earnings From Top 3 Crops in 1983 (Zaires)
Luiza			
I+S	87.5	peanuts maize manioc rice soya potatoes garden products	2043.4
N	100.0	maize peanuts manioc	665.2
Dibaya			
I+S	86.4	manioc maize tomatoes beans peanuts plantains onions soya other	549.4
N	75.0	beans peanuts manioc	1037.5
Kananga			
I+S	21.2	pineapple manioc peanuts beans pistachios other	536.9
Rural			
D	100.0	manioc maize peanuts tomatoes eggplant pepper	746.3

In the rural areas, 31% of the initial adopters felt they made more money from their ponds than they did from sales of their three top cash earning crops in 1983. All of the Kananga initial adopters who sold some produce from their fields found fish cultivation to be more profitable. Among urban secondary adopters, however, the situation was reversed. All urban and 96% of the rural secondary adopters believed that their crops earned them more money than selling tilapia did. In general, those who thought they were making more money from harvests of their ponds were earning substantially less on their fields than were farmers who felt that crop production was more profitable. The median value of the money earned on the most important crop sold by farmers in Luiza for whom fish culture was more profitable was Z200, compared to Z3500 earned by those who indicated crop production was more profitable. The range was smaller for farmers in Dibaya, Z320 versus Z500 for the same categories.

The value of fish obtained from the most recent harvest in 1983 is shown in Table 20. Initial adopters in all areas made more money from their most recent fish harvest than did secondary adopters (1.6 to 3.2 times as much). Again, this was principally due to their having built larger ponds and from practicing superior management techniques (as reflected in higher yields).

In both rural areas, the cash resulting from one harvest of tilapia was significantly less than that earned from the sale of a portion of the year's crop production. In Kananga, however, the amount of money generated from initial adopter harvests exceeded the average value of crop sales for the year (Z585 versus Z335).

Table 20. Value of Tilapia Obtained From the Most Recent Harvest (1983)

Category	Average Total Value of Fish Sold (Z)	Average No. of ARES Harvested (mean)	Total Zaires EARNED per ARE	Average No. of Kilograms (median)	Percent of Households CONSUMING All Fish AT HOME	Estimated Total VALUE[a] (Zaires)
INITIAL ADOPTERS:						
Luiza	303.9	2.1	144.7	22.3	31	892.0
Dibaya	155.6	1.3	119.7	7.5	37	300.0
Kananga	584.7	3.8	153.9	21.0	17	840.0
SECONDARY ADOPTERS:						
Rural	96.0	0.7	137.1	7.7	40	308.0
Kananga	181.0	1.9	95.2	8.3	26	332.0
DROP-OUTS:						
Rural	89.2	1.2	74.3	3.5	17	140.0
Kananga	89.3	1.4	63.8	3.7	65	148.0

[a]Home consumption is taken into account by multiplying the median value of kilograms harvested times a representative price of Z40 per kilogram for 1983.

Two points are worth noting. First, the farmers in question were likely to have had several harvests during the year, and second, a substantial percentage of households in every category consumed all the tilapia they produced. Only 3% of the secondary adopter households in Kananga sold all of the fish from their last harvest. In the remaining cases, at least some of the harvest was consumed at home. Assuming a representative value of Z40 per kilogram for

all tilapia raised in Kasai Occidental in 1983, the home consumption of fish from the most recent harvest accounted for 66% of the value of total tilapia production among initial adopter households in Luiza, 48% in Dibaya, and 3% in Kananga. The situation was similar among secondary adopters as well. Home consumption equaled 69% of the last harvest value among rural households, and 45% among urban ones. Obviously, the value of ponds is greatly underestimated if home consumption is ignored.

A significant quantity of fish is also obtained for home consumption from fishing done by household members during the months preceding the harvest itself. This practice is discouraged by the extension agents among newcomers to the program to prevent overfishing that could lead to disappointing yields at harvest time. Most of the farmers in this survey had already been raising tilapia for some time and a high proportion of them (63 to 73% depending on the area) reported that they did some fishing on a regular basis. As to the effect of intermittent fishing on overall production levels, much depends on whether or not it takes places at a sensitive stage in the tilapia's growth cycle. If the farmer removes one of the original fingerlings before reproduction has begun, the effect will be negative. Conversely, if smaller fish are removed in the fourth or fifth month of the production cycle, more space and nutrients become available for the remaining individuals. Children were frequently dispatched to do the fishing, often without much instruction as to which ponds should be exploited.

The most intensive amount of fishing from the ponds at non-harvest times occurred in Kananga (Table 21). Fifty-five percent of the pond-operating households in the city fished at least once a week, compared to 31% of those surveyed in Luiza and 27% in Dibaya.

Table 21. Frequency of Fishing for Home Use Reported by Initial and Secondary Adopters Surveyed

FREQUENCY OF FISHING FOR HOME USE	LUIZA	DIBAYA	KANANGA
	(Percent of Households)		
Infrequently	37.6	27.3	35.3
One to Three Times per Month	25.0	40.9	7.9
Once or Twice a Week	18.8	27.3	25.5
Three to Seven Times per Week	12.6	0	29.4
Did not know	6.0	4.5	1.9
% of households that ate fish from own ponds during the month preceding the interview	87.5	100.0	92.0
Mean number of times ate fish from own ponds during the month preceding the interview	2.7	2.0	5.0

Based on responses reported in Table 21, three possible scenarios were constructed for the extent of home consumption of fish that results from fishing out of the ponds in between harvests. Two estimates for the number of times per month that pond operators fish out of their own ponds were derived from the previous table: (a) values are the weighted averages from responses to the question asking how many times per week did any member of the household usually fish out of the pond (7.0, 4.6, and 2.2 times a month for Kananga,

Luiza and Dibaya, respectively); (b) values are averages of the actual number of times the farmer fished out of his/her pond during the month previous to the interview. Three possible levels of intensity of home fishing were selected: 1) Low--the removal of 125 gms. of fish each time; 2) Medium--the removal of 333 gms. of fish each time; and 3) High--the removal of 1 kg. of fish each time. Granted the quantity obtained on different occasions would vary considerably depending on need. However, these average estimates of intensity reflect actual cases observed by the author.

The medium intensity scenario presented in Table 22 provides the best approximation of the contribution of pond fishing to home consumption. More frequent fishing would have led to a more significant decrease in the yield from harvests than was reported by the farmers in the survey. Using a value of Z40 per kilogram for 1983, the total worth of tilapia obtained by fishing for home use ranged from an estimated low of Z320 in Dibaya to Z720 for Kananga.

Table 22. Estimated Kilograms of Tilapia Obtained by Fishing For Home Consumption Per Year

Zone	Average No. of Times per Year Fishing Occurred	Intensity of Fishing Out: LOW	MEDIUM	HIGH
		(Kilograms per Year)		
Luiza	a) 55.2	6.9	18.4	55.2
	b) 32.4	4.1	10.8	32.4
Dibaya	a) 26.4	3.3	8.8	26.4
	b) 24.0	3.0	8.0	24.0
Kananga	a) 84.0	10.5	28.0	84.0
	b) 60.0	7.5	20.0	60.0

Thus, it appears that pond operators from the city in particular were benefiting substantially from home consumption of the pond fish in addition to income earned. The income generated by the sale of tilapia in Kananga was higher than the average for both rural areas for the most recent harvest. Yet the absolute value of the income must be examined in relation to the higher cost of living found in the Kananga as opposed to the rural sector.[2] Figure 5 demonstrates how the nominal base wages of government employees and the price of the two most important basic foodstuffs (manioc and maize) have continued to rise since the project's inception in 1978. Two salary grades are presented: the agent de bureau first class is representative of a middle grade of government service, equivalent to a secretary having six years of secondary schooling; agent auxillier first class is a lower grade level held by persons like primary school teachers who would have completed four years of secondary schooling themselves. The salaries in the higher grades of government service increased at a much faster rate from 1978 to 1983 than did those of the lower echelons.[3] Base salaries were usually supplemented from 5 to 10% with an allowance for transport, each child in the family, and, for those with a higher grade, lodging. The allowances in most instances were extremely low, e.g. the allotment for one child in 1982 was only two Zaires per month.

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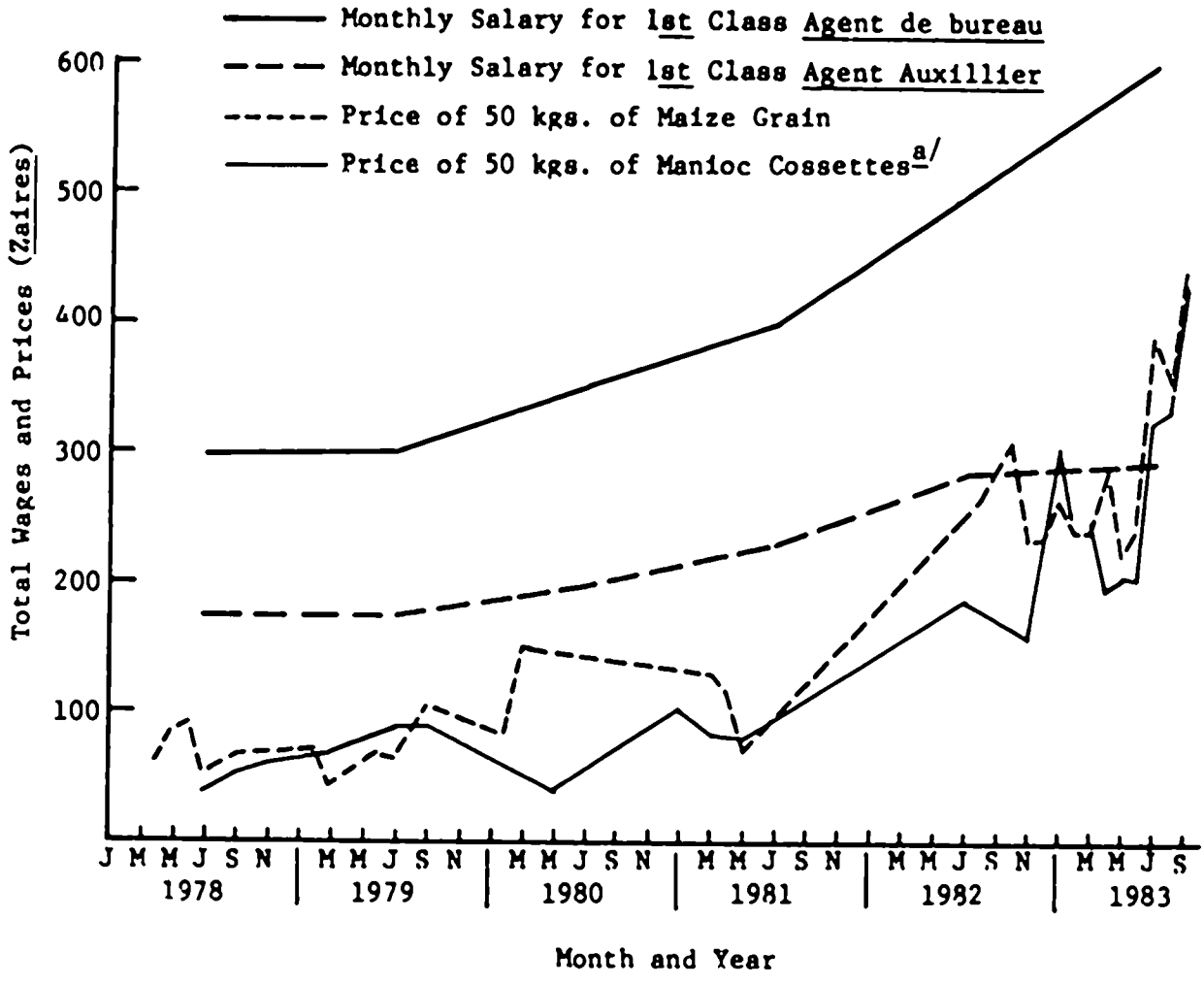
[2]Some comparative prices for basic foodstuffs in the three areas surveyed will be presented in Chapter VI.

[3]The system of grading used to determine base salaries for workers in government or private companies is complex. Information gathered on base salaries payed to eleven levels of wage earners from 1978 through 1983 is compiled in Appendix C.

FIGURE 5. NOMINAL WAGES AND PRICES: MONTHLY GOVERNMENT SALARIES vs. THE COST OF FOOD STAPLES



a/ Statistics regarding manioc are reported in three forms: tubers, which is the whole root; cossettes, after the manioc has been soaked, peeled, dried and broken up into smaller pieces; and flour, whether it was pounded by hand or ground at a mill.

When the escalating consumer price index is taken into account for this period, the constantly fluctuating price of manioc and maize in real terms actually declined somewhat from late 1978 to mid-1983. Wage increases failed to keep pace with inflation, however, and a steep decline in the purchasing power of government salaries resulted. As can be seen in Figure 6, purchasing power for basic foodstuffs fluctuated depending on the time of year, but the overall trend was downward. In addition, maize prices were probably affected by whether or not a significant quantity of imported maize was reaching Kananga or not. The number of kilograms of manioc that could be purchased monthly by a first class agent de bureau in Kananga fell from 390 in June of 1978 to 70 in September of 1983. With a purchasing power of 34 kilograms, the lower grade agent auxillier could not even affort to purchase one sack of manioc with his/her entire monthly salary in September of 1983.

Data collected on daily expenditures among nine initial adopter households in Kananga from November 1983 from January 1984 are shown in Table 23. The primary income generating activities are listed and the households ranked by level of weekly expenditures from highest to lowest.

FIGURE 6. PURCHASING POWER OF GOVERNMENT WAGES

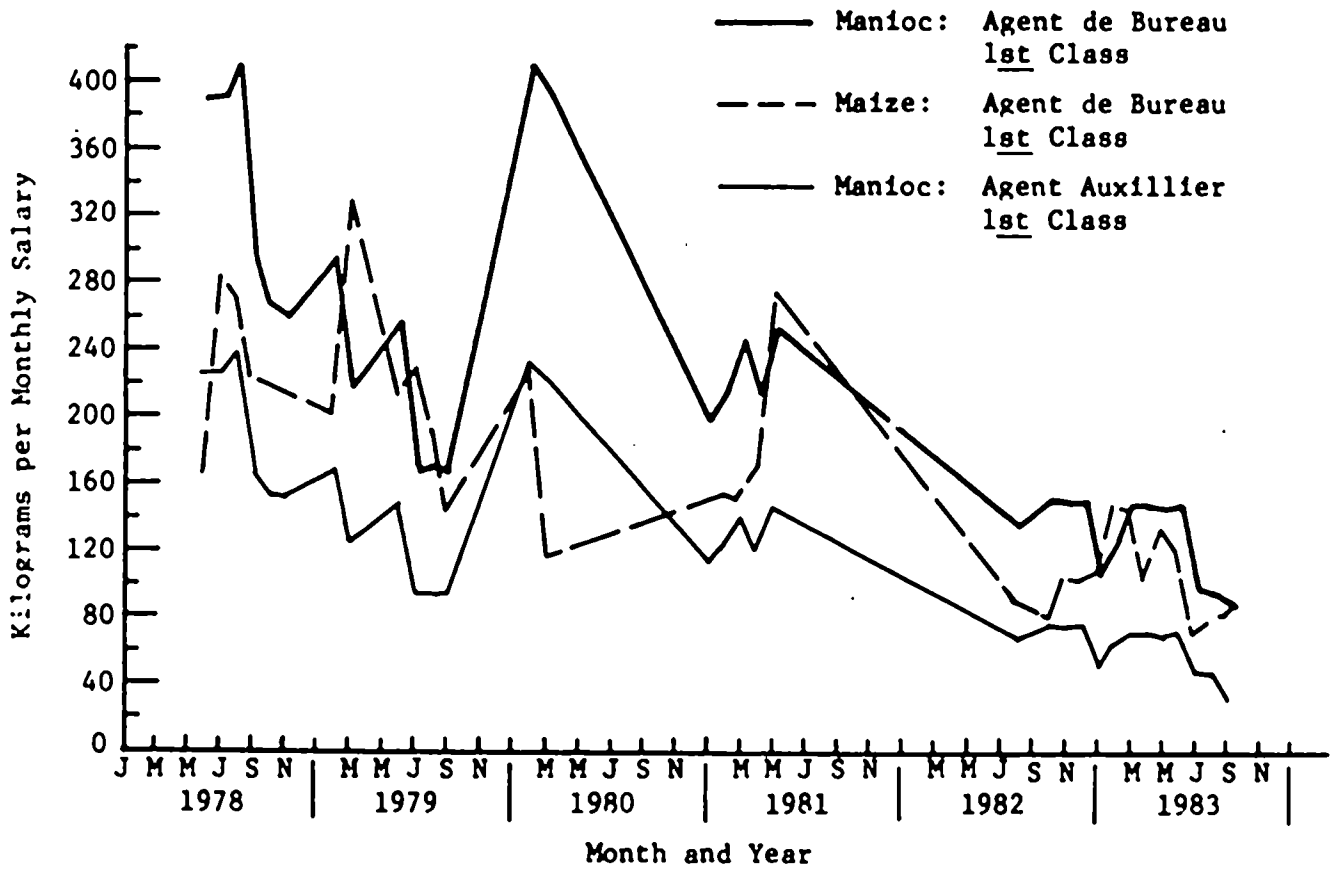


Table 23. Average Weekly Expenditures Reported by Nine Initial Adopter Households in Kananga (November 1983 through January 1984)

FARMER	Principal Income Generating Activity	No. Weeks Surveyed	Total Weekly Expenditures (in Zaires) MEAN	(SD)	No. Adults (>15 years)	No. Children (<15 years)	Weekly Expenditures (in Zaires) Per Adult	Per Member
1	Diamond Digging	10	3031	(1265)	7	4	433	276
2	Teaching[c]	12	1797	(888)	7	7	257	128
3	Teaching[a c]	8	1230	(429)	8	7	154	823
4	Electrician[d]	11	774	(421)	6	4	129	77
5	Teaching[a]	11	718	(392)	3	7	239	72
6	Teaching[b]	10	653	(212)	3	6	218	72
7	Crops	11	583	(285)	3	5	194	73
8	Secretary[d]	9	506	(241)	4	6	126	51
9	Palm Wine	11	312	(150)	2	7	156	35

[a]Both the male and female head of the household engaged in the principal income earning activity.

[b]At a higher salary level than for most teachers as the male head had completed 6 years of secondary school.

[c]At a higher salary level than most teachers because they were principals of primary schools.

[d]Employed by the government.

All but two of the households received a wage salary (five households from the state; two households from the Catholic Church). Base salaries accounted for less than a quarter in some cases to slightly over a half in others of the household's average monthly income needs. The variation in weekly expenditures was considerably reduced when the amount spent was divided by the number of adults

residing in each household. Variation of the total average weekly expenditures among the different households was high due to differences in the nature of the principal income generating activities as well as the number of potential adult workers found in each household.

The income from pond culture averaged far below the average weekly expenditures reported by the head of the diamond digging household.[4] A typical harvest for an initial adopter could generate Z500 or more. This would meet or exceed the weekly expenditure needs of the three households found at the lower end of the spectrum, but is somewhat less than that reported by the middle group. With an average 7.4 ponds per initial adopter household in Kananga, farmers possessed the capacity to have 12 to 14 harvests a year. For households expending less than Z1000 a week, fish culture could provide up to a quarter of their monthly income needs. Thus, for wage-earning households in this group, pond culture played a similar role as the base government salary did in generating household income.

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[4]The farmer in question did not reveal that income was coming in from diamond digging until the survey was well under way and the author was trying to find out why the expenditures for this particular household were so high. There were no obvious signs of wealth on the parcelle: the farmer was in his late forties, wore simple clothes, and the house was mud brick. The only sign of some money being available was the gradual addition of new tin sheets to the roof of his mud brick house. It turned out that his first son, who was rarely to be found on the parcelle, was doing the digging and remitting the money to the household.

Comparison of Fish Pond Culture versus the Value of Other Animals Found in Pond-Owning Households

The biological advantages of raising tilapia over other forms of animal husbandry have already been mentioned. From the standpoint of disease resistance, there is very little risk involved in undertaking in fish pond culture. The cost of obtaining the initial stock is low--the price of 100 fingerlings in December 1983 in the Zone of Dibaya, for instance, was the equivalent of purchasing a pair of two small guinea pigs (Z40). After the initial stocking, the majority of initial adopters (67%) never had to purchase fingerlings again.[5] Forty-eight percent of all secondary adopters bought fingerlings only once. In addition, a well-constructed pond could withstand periods of management neglect and the fish would continue to grow at the slow rate of natural production.

The comparison between the value of tilapia and other domesticated animals owned by the farmer must be made in an approximate manner. Fish must be assessed in terms of potential yields from a given surface area whereas the other animals can be assigned a value per individual. The average number of animals owned per household was taken from the table in Chapter IV and multiplied by market values for each adult animal as of January 1984. Totals shown in Table 24 represent the market value of other animals possessed by initial and secondary adopter households. The mean values were Z13,999 in Luiza, Z4,783 in Dibaya, and Z4,468 in Kananga.

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[5]Of those initial adopters who did have to purchase fingerlings a second time, in 73% of the cases it was because they had completed their second pond before the original fish had reproduced in the initial pond stocked. Only 9% of the initial adopters had to purchase fingerlings more than twice.

Table 24. Average Value of Other Animals Found in Pond-Owning Households[a]

ANIMAL	LUIZA Mean No. per Household	LUIZA Value of 1 Adult Animal (Z)	LUIZA Total Value for Household (Z)	DIBAYA Mean No. per Household	DIBAYA Value of 1 Adult Animal (Z)	DIBAYA Total Value for Household (Z)	KANANGA Mean No. per Household	KANANGA Value of 1 Adult Animal (Z)	KANANGA Total Value for Household (Z)
Cow	0.9	8,000	7,200	0	9,000	0	0	12,000	0
Goat	3.8	920	3,496	2.6	1,000	2,600	1.4	1,400	1,960
Pig	1.4	960	1,344	0.1	800	80	0.1	1,800	180
Sheep	1.1	575	632	0.1	700	70	0.4	1,200	480
Duck	1.6	135	216	1.0	250	250	1.1	250	275
Guinea Fowl	0.4	110	44	0.7	200	140	1.1	350	385
Chicken	7.7	100	770	6.8	170	1,156	2.2	220	484
Rabbit	1.1	90	99	2.5	105	262	1.5	250	300
Pigeon	0.6	35	21	1.2	50	60	5.2	70	364
Guinea Pig	5.9	30	177	4.7	35	164	0.9	45	40
TOTAL			13,999			4,783			4,468

[a]Based on ranges of prices in January 1984 obtained from markets or from individual farmers.

In order to compare these values to that of fish, an estimate of the potential value of fish production for the household was made based on market values of fresh tilapia as of January 1984. In assessing the yield potential for pond culture, yields obtained from the most recent harvest were used as the base guidelines for comparing differences in yields reported by initial adopters, secondary

adopters, and drop-outs (refer to Table 25). Because of their small sample sizes, the secondary adopter and drop-out categories in the rural areas were combined. Yields from the most recent harvest reported by survey participants were at least 50% lower than average values recorded for farmers working with project extension agents in the same Zones in 1983.[6] They are indicative of the lower level of extension contact being received, and probably serve as more accurate predictors of production levels that will be maintained in the long run. This will be discussed further in the next chapter.

With reference to farmers in this survey, the total potential gross value of fish ponds belonging to Kananga initial and secondary adopters was greater than the combined value of all other animals owned. This was not the case for pond-operating households in either of the rural areas. Moreover, the cost of raising other forms of livestock, excluding cattle, was minimal as most animals were allowed to roam freely in search of their own food. The net value of tilapia produced would compete more favorably when compared to individual categories of other animals, except for cattle in Luiza and goats in Dibaya. If, however, yield figures similar to those cited in the 1983 report could be realized, then the value of output for initial adopters in Dibaya would exceed that of other animals found on the parcelle. Likewise, in Luiza, tilapia would be worth 95% of the value of other animals. Based on these figures, drop-outs who reactivated their ponds, but were unable to improve upon their

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[6]Average yields reported for ponds harvest by farmers working with extension agents in 1983 throughout the Zones of Luiza, Dibaya, and in Kananga were 41.8, 32.7, and 35.0 kgs./are/year, respectively.

previously obtained yields, would have little incentive to emain in fish farming instead of raising other animals.

Table 25. Estimated Potential Gross Value of Annual Fish Production As of January 1984

CATEGORY	YIELD (Kg/are/ year)	AVERAGE NUMBER OF ARES OWNED[a]	KILOGRAMS PRODUCED ANNUALLY	ANNUAL VALUE OF PRODUCTION AS OF JANUARY 1984[b] (in Zaires)
INITIAL ADOPTERS				
Luiza				
Most Recent[c]	21.4	6.7	143.4	6,452.1
Dibaya				
Most Recent	11.2	3.6	40.3	1,814.4
Kananga				
Most Recent	17.9	13.1	234.5	10,552.1
SECONDARY ADOPTERS				
Urban	15.5	7.1	110.1	4,952.2
Rural	13.1	2.1	27.5	1,238.0
DROP-OUTS				
Urban	8.5	3.4	28.9	1,300.5
Rural	7.1	1.2	8.5	383.4

[a]Median values were employed as they were more representative than the means.

[b]A representative value of Z45 per kilogram was used.

[c]Yield and kilograms produced are average values reported for the most recent harvest prior to the survey.

In summary, the most important aspects of adoption of fish pond culture by risk-averse subsistence farmers were its contribution to combatting seasonal deficiencies in food supply and providing and emergency source of cash. A high level of home consumption at harvest time was noted in all areas (30 to 60%), the least significant amount occurring in Kananga where the importance of fish sales as a means of generating cash predominated. At the same time, however, the incidence of fishing from ponds in between harvests was the highest in the urban area, particularly among secondary adopters.

Ironically, the economic benefit of raising tilapia compared to other activities was smallest in Luiza, the area which had the greatest physical potential for fish production. Fish culture complemented but could not compete with crop cultivation as a primary source of cash generation in areas with better agricultural resources. Nor could it begin to match the amount of income that could be generated through successful small-scale diamond digging when that opportunity was available. Middle to lower level government workers in Kananga who had access to sufficient quantities of land and fish feed realized the most cash from operating ponds. It was not the quantity of zaires earned, but the timing of their generation that made raising fish for most rural farmers an asset.

The potential market value of tilapia as a form of animal protein was highly significant when contrasted to other forms of animal raising, particularly in Kananga and Dibaya. Both are highly desired, though fish and meat are expensive sources of nutrients when compared to non-animal protein and carbohydrate sources. However, through

its year-round availability, pond fish filled important gaps in protein availability, especially in the dry season.

The costs of engaging in pond culture were not negligible. Among these costs are the opportunity costs of foregoing other activities, and losses associated with health problems, predation, pilfering, the lack of materials or sufficient labor, or adequate management experience. These costs must be weighed against the aforementioned benefits. Subsequently, factors which led farmers to drop out of the program will be examined, as well as the major constraints faced by those who have continued to produce tilapia.

B. The Costs: Land, Material, Labor, and Social

Land Tenure

As is the case in many parts of Africa, most Zairian land is controlled by all members of the community group or clan. Non-clan members acquire use rights on land through marriage, special arrangements with the village head, or agreements made through local or regional administrations. National legislation passed on July 20, 1973 stated that officially all land is the exclusive. unalienable, and imprescriptible property of the state (Mwamufiya, p. 23). In practice, most site selection for crop production in less-populated rural areas was either an individual decision or determined by the village chief, often in conjunction with the local agronome, just before the beginning of the cropping season. In his study on maize production in Kasai Oriental, Mwamufiya (p. 76) found that limitations to the total amount of land held by a family were more influenced by such

factors as the extent of available family labor, population density, and the distance from the village to good land than by allocations made by governing authorities.

P.P.F. project personnel never became involved in the distribution of land, nor in the ultimate determination of land rights issues. In rural areas, valleys were often forested, and used for the extensive production of palm nuts or for gathering firewood before pond culture was introduced. Farmers were responsible for determining whether or not a site "belonged" to someone else. In some instances, several different valleys would have to be visited before one was found that met all the technical criteria for pond construction. Conflicts arose in situations where several farmers within a given radius containing only a limited number of suitable valleys expressed interest in pond culture. A typical response to such high demand would be a rush to clear and build as many ponds as possible in order to claim one's territory. In these cases, the proper construction of derivation canal systems, necessary for the common good of all in the valley floor, was often ignored unless some intervention was made by the extension agent at an early stage.

Problems of this nature reached an apex in densely populated Kananga where the initial adopters developed the best and most extensive sites before interest in pond culture intensified. Technically, legal tenancy of land could be arranged through two sub-divisions of the Regional Division of Land Registry that was charged with the regulation of parcelle distribution. The first sub-division, the Cadastre, is responsible for performing land surveys; while the actual recording of land ownership and its transfer or lease

is accomplished through the Tabellion (Nzongola-Ntalaja, p. 301). As land registration was an expensive proposition, the general rule of conduct was to respect the rights of whoever claimed it first. Several farmers mentioned, however, that a site which had been neglected for three years or more could be utilized by someone else. Any previous claims to palm tree ownership were often honored by the fish farmer by building the pond around the tree in question, or letting it remain in the dike.[7]

Two of the initial adopters went through the official land leasing process. One was a fairly prosperous individual whose ponds were part of a much larger farm concession which he had already leased before the project began. The other was a younger schoolteacher who had neither the labor supply nor adequate time to quickly exploit all the land he desired. He decided to go through the registry agency in order to prevent his neighbor from building a pond in the same valley. The total cost of leasing the land for five years (from 1981-1985) came to Z4417, and consisted of three parts:

1) Cost of permit to develop the land for fish ponds and inhabit the parcelle above the ponds:..... Z 150.00

2) Fee paid to the Cadastre for surveying the land and to purchase the contract for temporary land occupation:..... Z1400.00

[7]It was illegal to cut down any palm tree--the result of an ordinance passed to help deter declining palm oil production. However, too much shade from palm trees can result in slower plancton growth and lower temperatures, while the extensive rooting system in dikes encourages leaking. Consequently, palm tree removal was usually advocated by the extension service.

3) Rental payments to the Tabellion:

1st year (1981).....	Z 184.39
2nd year (1982).....	Z 447.13
3rd year (1983).....	Z 638.75
4th year (1984).....	Z 798.43
5th year (1985).....	Z 798.43

Though the initial capital input was high, especially given the low wage prevailing for school teachers, the farmer had the advantage of being able to construct larger, well-built ponds and continuous canals without much interference.

As the perceived worth of the fish ponds increased, there was a concurrent rise in the incidence of disputes over land rights. Conflicts over land registration were usually difficult to resolve. Any cases taken to city authorities required giving up a considerable amount of money and time. The most extreme case encountered in Kananga occurred in 1981 when a businessman purchased a valley in which nineteen farmers had ponds already in production. The businessman had back-dated the official documents to state that the original purchase had taken place two months before the first pond was constructed, so the farmers had no legal basis for contesting the appropriation. Intervention by P.P.F. resulted in the farmers being compensated for their ponds, but the agreed upon Z250 payment per are was far below the long-term value of the pond.

Moreover, the ponds themselves began to acquire a monetary value as a factor of production and instances occurred where marginal fish producers sold their ponds to neighboring farmers when an emergency created a need for cash. Transfer of ownership also resulted from the substantial abandonment of sites by secondary adopters in 1983. Initial adopters and others in Kananga who had lacked previous access

to sites, gradually began to acquire the better technical locations. However, the monetary value of land remained low if the resale figures for ponds in Kananga reported by the four initial adopters who kept records of purchases are indicative of the overall situation. Table 26 shows that although the extremely low nominal prices per square meter that prevailed in the mid-1970s had doubled or tripled by 1983 to values ranging from Z1.3 to Z1.7 per square meter, the total price of the pond never exceeded what could be earned from one fairly well-managed six month production period.

Table 26. Value of Ponds Purchased by Four Initial Adopter Households in Kananga

Year of Purchase	Total Zaires Paid per Pond	Total Area per Pond (meters)	Zaires Paid Per Square meter
1975	40	648	0.06
1976	40	1025	0.04
1976	32	596	0.05
1978	60	246	0.24
1979	60	86	0.70
1981	35	336	0.10
1981	300	176	1.70
1981	40	287	0.10
1982	172	240	0.70
1983	350	188	1.90
1983	100	77	1.30
1983	150	110	1.40
1983	200	117	1.70
1984	1000	640	1.60

The non-intervention approach of the Project regarding disputes over land rights was successful in reducing apprehension among rural farmers about the Project's government-backing. In general, sufficient sites were available in rural areas so having to resolve disagreements through official channels--highly susceptible to corruption--was avoided.

The viability of such a strategy in the densely populated urban valleys was quite different. The combined effects of high visibility and rapid expansion of pond culture led to frequent attempts by government authorities to impose taxes as well as seek profit in handling complaints about land usage. Project involvement, usually in the form of damage control, was often necessary. Thus, regulating site exploitation with the commencement of any new urban programs in Zaire would probably yield substantial benefits in terms of long-term sustainability for these highly visible operations.

Materials: Tools and Fish Feed

The presence of different sorts of tools in each of the research areas has already been mentioned. The lack of tools was cited as being the most important problem encountered in raising tilapia by 23% of the initial adopters in Luiza, 13% of those in Dibaya, and 17% of the farmers in Kananga. However, among all the tools employed in pond culture, only the lack of shovels and machetes was frequently mentioned.[8]

Almost as significant as the variability in tool availability was the cost and quality of those tools purchased. Complete price information on the two most basic tools (shovels and machetes) for the period since the project's inception was only found in Kananga. Figure 7 demonstrates that nominal prices for both implements have

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[8]If a farmer specifically mentioned the lack of a particular tool, it was noted next to the "lack of tools" response on the questionnaire form. Though other tools may have been lacking as well, it was felt that posing a question about the need for each individual item would only have elicited positive responses.

risen at a faster rate than the price of tilapia.[9] For example, in 1979 one kilogram of fish was equivalent in value to 5.7 machettes; by January 1984 one kilogram of fish would not have been enough to purchase even a single machette. Similarly, one shovel was equivalent to 1.3 kilograms of tilapia sold in 1979, and to 2.8 kilograms in 1984.

The prices shown in Figure 7 are for tools manufactured in Kinshasa and sold by a development organization (PROPA) at cost in Kananga. Prices of equivalent tools in city markets or imported tools in stores were often much higher (by 10 to 300%). Expensive shovels of excellent quality were available periodically on the Kananga market and were oftened referred to as "diamond" shovels. However, it should be noted that initial adopters in the follow-up survey who reported the prices paid for tools in various years, most often cited figures that were anywhere from two-thirds less to one-tenth higher than those charged by PROPA.[10] This was due to a reliance on local blacksmiths by most rural fish farmers and by a substantial portion of urban dwellers. The blacksmiths forged hoes, machetes, axes, and coupe-coupes[11] principally from scrap

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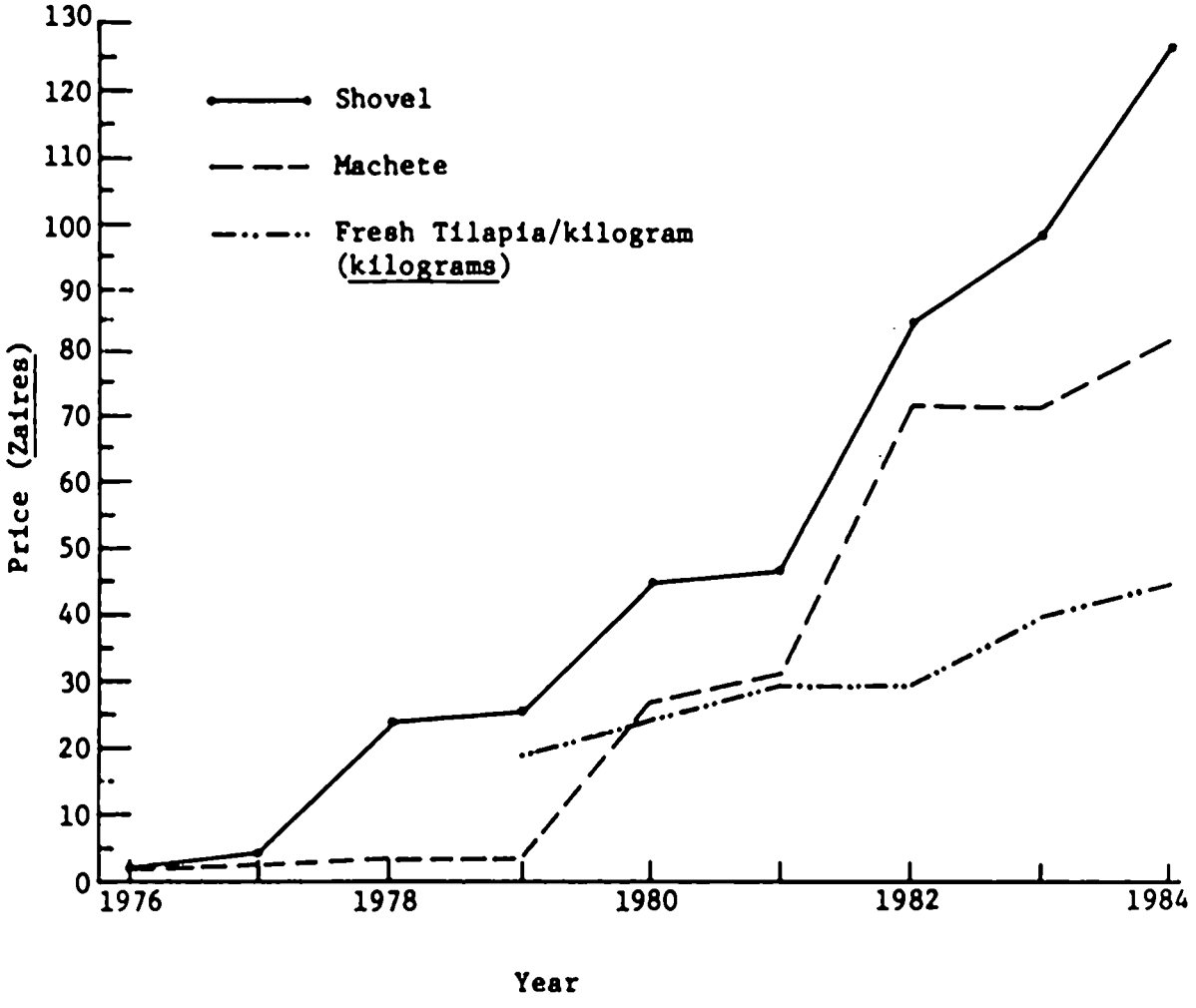
[9]Price per kilogram of tilapia sold is an average value based on station prices at Katuishi. The value per kilogram of larger fish (> 80 grams) was higher than the price listed here; that of smaller fish was less. Farmers often sold their product for 10-20% more than the set station prices. However, the restriction that all fish normally had to be sold the day of the harvest (unless dried) could force a portion of the harvest to be sold at a much lower price or consumed at home.

[10]For example, the prices paid by farmers in 1983 for machetes, for which recall data are rather accurate, ranged from Z25 to Z80 for urban dwellers and Z15 to Z38 for rural residents. In contrast, the average PROPA price for a machete in 1983 was Z72.

[11]A coupe-coupe is a long-bladed tool curved at the end. Sharpened on both sides, its principal use is for cutting grass.

FIGURE 7. NOMINAL PRICES OF BASIC TOOLS AND FRESH TILAPIA IN KANANGA, JANUARY 1976-JANUARY 1984



Source: Kasombo Mbala Buan'a Tching, Director of Promotion du Payson (Kananga).

materials. Shovels were of two types--the spade (bêche) and a less-curved version (pelle), but were rarely fabricated by local smiths. The longevity of each tool was highly variable, depending on the quality of the raw materials and the degree of stress to which it was subjected.

Data on the average number of tools owned by initial adopters as recorded from the 11 urban and 10 rural households included in the more detailed follow-up survey are shown in Table 27. Items such as machetes and hoes that were used intensively in crop production as well as pond construction displayed a high rate of depreciation. A substantial proportion of shovels found both in the urban and rural households were either broken or in extremely poor condition. The mean age of a shovel still in working order was 2.3 years in Kananga and 2.1 years in the rural areas.

Table 27. Status of Tools in 11 Urban and 10 Rural[a] Initial Adopter Households

TOOL	KANANGA			RURAL		
	Average No. per Household	Percent that are broken[b]	Average Age of Working Shovel (years)	Average No. per Household	Percent that are broken	Average Age of Working Shovel (years)
Machete	1.6	22	4.7	1.5	27	1.1
Shovel	2.7	60	2.3	0.9	44	2.1
Coupe-coupe	2.2	46	5.1	0.8	38	1.2
Ax	1.0	9	3.8	1.1	27	12.9
Wheelbarrow	0.4	60	4.0	0.3	100	
Hoes	3.2	11	2.2	3.6	0	2.3
Buckets	1.4	31	2.5	0.7	14	**[c]

[a]Five initial adopter households from Luiza; five from Dibaya.

[b]Percent of item found in the household that was broken or in very poor condition.

[c]Only one farmer remembered when his bucket was purchased.

It was not unusual for a farmer to borrow a shovel when constructing a pond. It is also likely that one of the reasons groups of friends or relatives were frequently enlisted in rural areas to engage in a few days of concentrated work on pond construction was that they came equipped with additional tools. Occasionally, farmers were encountered with shovels that had been distributed by the government for road maintenance. Conversely, instances occurred when shovels owned by fish farmers were borrowed by friends and relatives digging for diamonds. This competition for the use of tools had an additional dimension. When queried as to why truckers or bicycle traders did not bring shovels to the Luiza Zone where they were in such demand, two responses predominated. First, the respondents said the turnover rate for selling an entire batch of shovels was long because of their relative high price and the fact that, unlike soap and salt, they are non-essential items. Second, they pointed out that any trader transporting shovels out of the city would be assumed to be trafficking in diamonds, which could lead to harassment when stopped by local military officials along the roads.

On the whole, the only tool which would have been extremely useful to most fish farmers but was well beyond the price range of the vast majority, even when available, was the wheelbarrow. A poorly manufactured model with a metal wheel cost over Z3000 in Kananga in January 1984. The sole means of repair was by soldering, which had to be done frequently. Only two farmers were encountered who had functional wheelbarrows. This meant that pond construction had to be carried out by men digging out dirt with a shovel (women

usually used hoes) from the pond site itself and tossing it to the sides; or dirt had to be transported from the hillsides in baskets, buckets, or basins.[12] The mission at Masuika (in Luiza) had designed a wheelbarrow made entirely of wood (including the wheel), thus greatly simplifying the maintenance problem. As of late 1983, production was still in the very initial stages and the cost of the wooden wheelbarrow was also high for the average fish farmer (Z800-1000).

Two other items should be briefly considered as they are pertinent, but again, not essential for pond culture: nets and scales. The former were in high demand by farmers, though the fine-meshed variety required for catching fingerlings was not available on the local market. The only netting typically found was a wide-meshed gill net used in river fishing. Extension agents were supplied with imported synthetic fingerling nets by the Project. The Project had purchased a black netting that was manufactured within Zaire itself but whose mesh size was somewhat larger than the ideal for capturing fingerlings for restocking. Farmers could buy this netting through the agents but on the whole were dissatisfied with its efficiency, especially having previously been exposed to the finer-meshed version. Thus, the classic conflict arose between whether or not the Project should be selling imported or locally manufactured netting, or any netting whatsoever.

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[12]Use of soil from a pond bottom is not deleterious if it consists primarily of clay (once the organic matter and debris are removed). However, dikes made of sandy soils ideally should be cored on the inside with clay from the hillside to prevent seepage.

Scales, on the other hand, were rarely owned by fish farmers, unless they were associated with a farmers' group (committee) which had purchased one through the Project. Selling of both fish and meat in Zaire was usually done by piece or, in the case of fish, several were wrapped in leaves or placed in a small dish. The principal benefit of scales was to enable the Project staff to monitor yields at harvest time. Most rural farmers remembered harvests in terms of the number of buckets or basins obtained if the extension agent was not present.

Feeds: The Key to Adequate Production

The nutritional benefit of supplementary feeding is obvious--annual "natural" production in ponds alone rarely exceeds 6 kilograms per are. Moreover, the subject of feeding has two components: the enhancement of plancton growth through composting and the provision of such "supplementary" feeds as leaves, termites, and farinaceous by-products.[13]

Juvenile O. niloticus feed entirely on micro-organisms. If supplementary feeds are employed the conversion rates of those feeds are determined by the quantity of "natural" food in the pond that is already available. Thus, the amount and quality of supplementary feed used could be reduced by improving primary productivity. When composting, grasses, leaves, and kitchen waste material can be combined with animal manure in heaps around the edges of the pond to avoid

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[13]Decomposition of unutilized supplementary feed also contributes to plancton growth (primary productivity).

deoxygenation problems. The major drawback to utilization of organic manures for fertilization is the substantial quantities required for them to be effective. Maar et al. (1966) recommended the following rates of manuring per are:

Pig manure:..... 0.56-1.63 kgs. per week

Poultry manure:..... 1.12-2.24 kgs. per week

Cattle manure:..... 0.67 kg. per week

The quantities required are feasible only as long as the farmer has a sufficient number of animals to conform to the overall size of his/her operation and a willingness to tether or confine the animal for a portion of the day or night in order to facilitate manure collection.

Composting was the most difficult practice to have Kasaian farmers perform on a regular basis, mostly due to their lack of experience with the technique in general, plus difficulties involved in obtaining and transporting animal manures. Previously, it was mentioned that fish farmers in Luiza owned more animals on the average than did those found in Dibaya or Kananga. Yet only 31% of the initial adopters in Luiza reported that they composted all the time; 23% reported composting some of the time. Those 89% who did do some composting, however, utilized animal manure. Table 28 shows that the percent of initial adopters composting all the time was much higher in both Dibaya (53%) and Kananga (61%) than in Luiza. As expected, the use of animal manures in the urban area was more limited than for both rural sectors. Secondary adopters relied

more on just leaves and grasses for composting materials than did the initial adopters.

Table 28. Composting by Initial and Secondary Adopter Households (Percent of Total Number of Households Surveyed)

CATEGORY	THOSE WHO COMPOST: All the time	Some of the time	Of those who DO compost: Using just leaves and grass	Plus limited amounts of animal manure
Initial Adopters				
Luiza	31	23	11	89
Dibaya	53	0	12	88
Kananga	61	17	43	57
Secondary Adopters				
Rural	30	30	33	67
Kananga	38	24	71	29

The overall contribution of supplementary feed depends on the value of the feed itself (expressed as a conversion rate) and the frequency of feeding. Table 29 summarizes the principal feed usage by initial and secondary adopters in each area. Papaya leaves, termites, and manioc waste were consistently employed in Luiza and Dibaya. The initial adopter households in the two rural areas differed considerably in the extent to which they fed manioc leaves, sweet potato leaves, and rice bran. In Luiza, 54% of the initial adopters utilized manioc leaves all of the time. No initial adopters in Dibaya reported feeding manioc leaves all of the time, and 27% had given up the practice. Though 38% of the initial adopters in Dibaya continued to feed these leaves to their fish occasionally, the contrast

TABLE 29. FREQUENCY OF FEEDSTUFF USE BY INITIAL AND SECONDARY ADOPTER HOUSEHOLDS[a/]

(percent of households surveyed in each category)

	Initial Adopters									Secondary Adopters					
	Luiza			Dibaya			Kananga			Rural			Kananga		
Frequency of Use:	All the Time	Some-times	In the Past	All the Time	Some-times	In the Past	All the Time	Some-times	In the Past	All the Time	Some-times	In the Past	All the Time	Some-times	In the Past
Leaves:															
Manioc	54	38	0	0	33	27	11	28	6	30	10	20	24	18	12
Sweet Potato	0	31	0	20	60	13	22	39	6	30	30	0	12	21	15
Papaya	38	62	0	47	47	6	28	44	22	40	50	10	26	21	29
Other	8	31	0	20	60	7	17	44	0	67	33	0	46	46	8
Termites	38	62	0	53	40	7	0	56	17	50	50	0	12	15	21
Manioc Waste	38	54	8	13	27	7	17	50	6	20	60	0	71	15	6
Maize Waste[b/]	8	38	15	0	33	13	28	28	17	10	10	20	32	12	9
Brewery Waste[c/]	0	15	23	0	33	40	50	11	33	0	20	10	35	15	32
Rice Bran	0	8	8	7	80	13	0	22	22	0	60	0	0	6	38
Fretins	0	0	0	0	0	0	0	33	28	0	0	0	38	24	15

a/ Other feeds occasionally used in all areas: palm nut waste, soya meal; in Kananga: processed chicken feed, fruit skins.

b/ Includes bran and sweepings.

c/ In Kananga, brewery waste is delivered in a truck from the local brewery. In the rural areas, it refers to waste left over from home production of grain alcohol.

between the two areas is most likely due to the different local market values of manioc leaves. Manioc leaves were never encountered for sale in the weekly village markets in Luiza, even though other leaves could be bought. The same did not hold true in Dibaya, where a bunch of manioc leaves sold for Z3. This price was almost equivalent to that found in Kananga during the same month in January 1984 on a per kilogram basis (over Z5 per kilogram).

Although papaya leaves were not as abundant as leaves from cultivated manioc fields, they were preferable as a feed because they were not utilized as a human food.[14] Use of other leaves, such as sweet potatoes and squash, were also restricted not only because of their competitive value as a human food, but also due to their seasonal availability. Certain kinds of Acacia leaves were excellent composting material, and other varieties of local leaves were often used to feed fish. The higher level of rice bran utilization in Dibaya reflected the promotion of upland rice cultivation by missions in the area. Almost all bran was fed in the first half of the dry season.

Termites were an excellent feed and are found primarily in two forms: in small "mushroom" structures sprouting in the midst of open or cultivated fields and in larger mounds found on the sides

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[14]Partial harvesting of manioc leaves can begin six to eight months after the manioc cutting is planted (The root is usually harvested after 12 or 18 months). B. Gohl (p. 321) reports that research has shown it is possible to obtain more than 6 tons of crude protein per hectare a year with proper agronomic practices directed towards foliage harvesting of manioc. Extensive leaf removal does diminish root size, so farmers normally pick a limited amount of leafy material from an individual plant.

of trees in the forest.[15] The only danger was that as the production period progressed, or more farmers built ponds in the same vicinity, it became necessary to venture out farther in order to locate the mounds. The termites in field mounds also dried out by the middle to late dry season.

In the rural areas, cash was rarely used to purchase fish food. Ninety-three percent of initial adopters in Dibaya, and 100% of those in Luiza, bought no feed at all in 1983. Fourteen percent of the rural secondary adopters purchased manioc waste, 14% bought rice bran, and the remaining 72% nothing at all. The same was not the case for Kananga, where the majority of both the secondary and initial adopters purchased at least one kind of feed during 1983 (see Table 30). Brewery and manioc waste were the main feeds purchased. These were combined with many other sorts of leaves, except manioc. Maize waste[16] and the debris left from the sacks of dried fretin from Kalemie were also used but to a lesser degree.[17] Secondary adopters who did purchase feed bought smaller quantities but made purchases nearly as frequently as did the initial adopters. In 1983, initial adopters buying feed spent an average of Z215 compared to Z130 for secondary adopters. However, the standard deviations of expenditures for both categories are high.

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[15]Sharp-pincered soldier ants (mankenene) gathered by women from the large termite hills were sold in the market and not used as fish feed.

[16]This includes sweepings and bran. The production of maize bran declined in 1983 as one of the major mills in Kananga temporarily closed operations for most of the year.

[17]Fretin (in French) or mayela (in Tshiluba) refers to the finger-sized, dried Stolothrissa tanganicae principally from Lake Tanganika in Eastern Zaire.

Table 30. Fish Food Purchased by Initial and Secondary Adopter Households In the Year Preceding the Survey, Kananga Only

	INITIAL ADOPTERS		SECONDARY ADOPTERS	
	(Percent of Respondents)			
Principal Feeds Purchased:				
	brewery waste	(62)	brewery waste	(35)
	manioc waste	(28)	fretins	(21)
	fretins	(28)	manioc waste	(18)
	mill sweepings	(11)	maize bran	(9)
	maize bran	(11)	mill sweepings	(6)
	NO PURCHASE	(17)	rice bran	(3)
			chicken feed	(3)
			NO PURCHASE	(38)
Unit Food was Purchased by:	trailer load	(48)	bucket	(31)
	sack	(26)	sack	(31)
	basin	(13)	trailer load	(22)
	bucket	(9)	basin	(16)
	small dish	(4)	small dish	(0)
	(Number per Respondent)			
Frequency of Purchase:[a]	2.7	(1.6)	2.3	(2.3)
	(Cost per Respondent)			
Cost of Feed Purchased:[a]	Z215.3	(180.6)	Z130.3	(130.6)

[a] Averages are only for those households which purchased feeds. Standard deviations are in parentheses.

The relative value of each individual feed depends on its conversion rate as well as its current market price. Table 31 compares the cost of using different feeds to produce 25 kilograms of tilapia based on January 1984 prices. If a representative value of Z45 per kilogram for fresh tilapia is used, 25 kilograms of fish would generate Z1575 in cash. Because of its high conversion rate (20:1) and its relatively high price per kilogram (Z5.43), it would cost Z2715 to raise 25 kilograms of fish on manioc leaves alone. Thus, even if the necessary 500 kilograms of bulk could be gathered and carried to the pond, one would lose money by raising tilapia on manioc leaves in the city. Use of any of the remaining feeds, on

the other hand, would result in a profit. One is struck by the low cost per kilogram of feeding brewery waste, in particular. It was widely used as a fish food in Kananga because it was inexpensive.

Table 31. Conversion Value of Different Fish Feeds in Kananga (January 1984)

FEED	Percent Crude Protein Content[a] (per 100 gms)	Conversion Rate (kg feed: kg Fish)	No. Kgs. Feed Needed To Produce 25 kgs. of Tilapia	Cost of Producing 25 kgs. of Tilapia (in Zaires)
manioc leaves	24	20	500	2715.0
termites	36	N.A.	N.A.	N.A.
manioc waste	2	13	325	1014.0
maize bran	9	10	250	500.0
rice bran	11	8	200	N.A.
brewery waste, dried	19	12	300	90.0
dried fish	50	2.5	62	609.4

N.A. Not available.

[a] As percent of dry matter. Data from Bo Gohl, Tropical Feeds, F.A.O. Rome, 1981.

The case of brewery waste also exemplifies the problems which can emerge when there is only a limited supply of low-cost nutrients. Brewery waste was the only feed in Kananga that could be purchased in bulk by individuals. The city's commercial brewery, UNIBRA, must dispose of waste by-products and will transport it in tractor-pulled trailers to the buyer's location. In 1978, the brewery usually had an excess of waste and had adopted a policy of charging only for the transport cost. By the end of 1979, fish culture had expanded to the point where demand for the waste began to outstrip supply. The price of feed tripled but was still a bargain as a fish food (see Table 32). In 1980 and 1981, there was a severe cutback in supply (see Table 33) just as interest in pond culture exploded.[18] Concurrently, agricultural schools facing supply cutbacks and increasing prices of animal concentrate feeds from Shaba began to increase their proportional use of brewery waste. As a result, an intermediate stage in the selling of brewery waste developed in which an individual would purchase and dry a trailer load and then resell it by the bucket. In November 1983, the "retail" price of dried brewery waste ranged from Z1.0 to Z1.3 per kilogram compared to Z0.3 per kilogram when it was purchased directly. By the time the survey was conducted, increasing difficulties and delays in obtaining the waste caused 33% of the initial adopters interviewed and 32% of the secondary adopters to stop feeding brewery waste altogether.

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[18]The brewery was dependent upon foreign currency for purchasing malt, machines, and replacement parts. Production was irregular, although the long shutdowns experienced in 1980 and 1981 were avoided in 1982 and 1983 by permitting payments for beer to be made in coffee and maize.

Table 32. Value of Brewery Waste as a Fish Food in Kananga (January 1978-January 1984)

YEAR	Cost per Trailer load (Zaires)	Cost per kg. Brewery waste (Zaires)	Cost of Producing 25 kgs. of Tilapia (Z)	Value of 25 kgs. Tilapia (Zaires)
1978	10	.01	3	225
1979	30	.03	9	500
1980	100	.10	30	625
1981	150	.15	45	750
1982	150	.15	45	750
1983	150	.15	45	875
1984	300	.30	90	1575

Table 33. Brewery Waste Availability in Kananga[a]

YEAR	Number of Trailer Loads of Waste Sold	Approximate Number of Kilograms of Waste Produced[b]	Potential Fish Production[c] (tons)
1978	370	366,300	30.5
1979	281	278,190	23.2
1980	188	186,120	15.5
1981	163	161,370	13.4
1982	214	211,860	17.6
1983	352	348,480	29.0
1984	312[d]	308,880	25.7

[a]Data obtained from UNIBRA brewery in February 1984.

[b]Total kilograms produced was estimated by multiplying the number of trailer loads sold by 990 kilograms. The latter was based on a single weighing of a trailer load of brewery waste delivered to Katuishi fish station in October 1983.

[c]Based on a 12:1 conversion rate.

[d]Estimate based on maintaining production level of 6 trailer loads per week that was reported in February 1984.

The frequency and timing of feeding are important considerations not only in terms of augmenting the total amount fed daily but also in terms of assuring that the feed will be efficiently digested by the tilapia. Moriarty and Moriarty (1973) reported that acid secretion in the stomach of O. niloticus starts at dawn, only reaching an optimum pH level for digestive efficiency in the late evening. If food was given in several lots over a longer time period, it would spend more time in the stomach thus allowing for a more desirable digestive environment to develop (Balarin and Hatton, p. 37).

The extension agents advocated feeding pond fish twice a day, once in the mid-morning and again in the late afternoon.[19] As can be seen in Table 34, the majority of both initial and secondary adopters fed at least once a day.

Table 34. Frequency of Fish Feeding Among Pond Operating Households (Percent of Total Number of Households Surveyed in 1983)

	INITIAL ADOPTERS			SECONDARY ADOPTERS	
Frequency	Luiza	Dibaya	Kananga	Rural	Kananga
Twice a Day	15	33	39	20	50
Once a Day	39	40	44	50	35
2 to 3 Times per Week	0	0	6	20	3
Once a week	23	7	11	0	0
Irregular	23	0	0	10	6
Don't feed	0	20	0	0	6

[19]The timing of feeding is also related to temperature. Tilapia stop feeding when temperatures drop below 14 degrees Centigrade. During the dry season, fish frequently do not become active until late morning. Ross and Jauncey (1981) reported that temperature alone can account for a .45% difference in feed intake per 1°C. For example, a 30 gram tilapia has a maximum feed intake of 9% at 30°C versus 4.6% at 20°C.

Several factors other than availability of feed may have influenced feeding frequency. These include: 1) the distance from the farmer's home to the pond, 2) the presence of fields next to the ponds, 3) the amount of extension contact received by the farmer, 4) the amount of time involved in gathering the food, 5) whether or not the person(s) in charge of feeding the fish was (were) frequently absent, and 6) weather.

Data were collected regarding the first three categories for initial adopters, and on categories 2 and 3 for secondary adopters. When feeding frequency was examined as a single criterion for each area, no consistent patterns of behavior were seen that held for all pond-operating households (see Table 35). In initial adopter households, the average distance to ponds was approximately one kilometer or less. The maximum time spent walking to and from ponds was around one hour, if the farmer fed twice a day. Those who fed on a less frequent basis also composted less. In Dibaya and Kananga, the initial adopter households that fed more frequently also planted fields next to their ponds more often. The same situation did not occur in Luiza, where 57% of the farmers who fed at least once a day had fields next to their ponds compared to 67% of those who fed less often. However, there was a general trend among initial adopter households towards more frequent feeding by those who had had some contact with the extension service in 1983.

Table 35. Influence of Various Factors on Frequency of Feeding

(Percent of Survey Households in Each Category)

FEEDING FREQUENCY	No. in Category	Average Distance to Ponds (meters)	Percent with Fields next to Ponds	Percent Composting: All of the Time	Percent Composting: Some of the Time	Had Extension Contact[a]
Initial Adopters						
Kananga:						
Twice a Day	7	409	71	86	14	71
Once a Day	8	609	88	50	12	62
Less than Once a day	3	3517[b]	67	33	33	33
Dibaya:						
Twice a Day	4	1020	60	60	0	60
Once a Day	6	796	50	67	0	33
Less than Once a Day	4	1106	0	25	0	0
Luiza:						
Twice or Once a Day	7	1175	57	57	14	42
Less than Once a Day	6	721	67	0	33	33
Secondary Adopters						
Rural:						
Twice or Once a Day	7	N.A.	28	28	43	14
Less than Once a Day	3	N.A.	67	33	0	67
Kananga:						
Twice a Day	17	N.A.	12	24	29	41
Once a Day	12	N.A.	7	67	12	58
Less than Once a Day	5	N.A.	0	20	40	40

N.A.: Not Available.

[a]Among initial adopter households, this refers to whether or not they they received extension contact in 1983; for secondary adopters, it relates to whether or not <u>any</u> contact was ever made.

[b]Biased by one high value: 9800 meters.

Balarin and Haller (1983, p. 340) considered the economics of intensive fish culture in any country to have three major sensitive areas: (1) the availability of seed stock; (2) the presence of cheap feeds and fertilizers, and (3) labor costs. Of these, feed and fertilizers were the most expensive components of the intensive tilapia pond system, the incidence of cost increasing with intensification. Most farmers surveyed in this study had little difficulty is attaining self-sufficiency in fry production. The feed and labor criteria, however, were highly interrelated. "Cheap" feeds in the rural area often consisted of an abundant leaf supply that required substantial amounts of labor time to collect. In contrast, the use of the inexpensive feeds found in Kananga was only constrained by their limited supply.

Labor Use

Poor farmers in Africa have generally been found to be efficient in their utilization of whatever resources they may have. The introduction of any new operation such as pond culture must, therefore, be examined to see how it complements or competes with seasonal labor demands for other activities. It is useful to have an assessment of the actual amount of time devoted to performing pond-related activities compared to other endeavors, and to determine the extent to which various members of the household are involved in such activities. In so doing, one may to ascertain possible labor constraints and how they might be overcome or at least taken into account when making recommendations to pond operators.

An attempt was made to obtain labor input data through the use of recall information from a small group of participants in each research area and through direct observation of pond-related activities in Kananga. Information was collected on each member of the household concerning his/her participation in activities pertaining to pond culture or crop cultivation. Pondwork was divided into seven categories: clearing of the site, construction of canals and dikes, composting, supplementary feeding, maintenance of the site, harvesting, and marketing. Each of these operations needs to be examined individually in order to determine:

1) whether any seasonal labor shortage occurs that presents a serious constraint to fish production;

2) if factors such as health, education, family size, and the division of functions between the sexes operate in such a manner as to decrease the effective labor supply and its productivity; and

3) how many hours are required to perform the task under consideration.

Subsequently, it will be possible to explore how participation in pondwork interrelates with labor use in crop production or off-farm work. An examination of apparent bottlenecks to intensive year-round pond management will be made. These will be weighed against the complementary aspects of pond and non-pond monthly labor use to develop a generalized portrait of preferential harvesting periods for each area surveyed.

An Overview of Participation by Age and by Sex

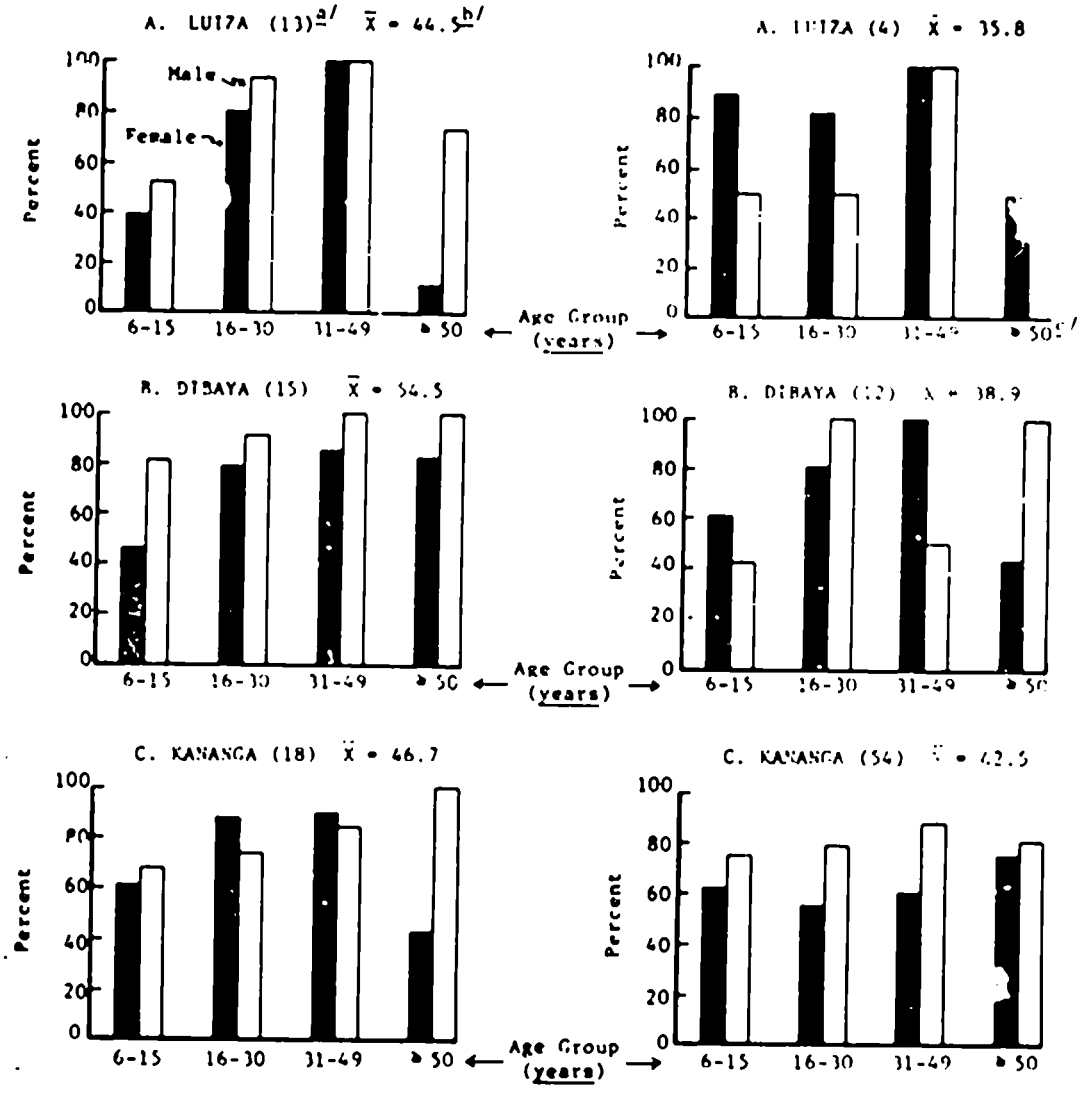
A general overview of the extent of participation by age and sex among initial, secondary adopter, and drop-out households in

each Zone is shown in Figure 8. A person was considered to be active in pondwork if that individual contributed his or her labor towards any one of the aforementioned divisions.

These graphs illustrate who does the work required to build and care for ponds. The highest percentages of both male and female participation in pondwork were reported to occur among persons 31 years of age or older. While male participation in pondwork in rural initial adopter (I) households was greater than or equal to female participation, the situation was much more variable among secondary adopter and drop-out (S+D) households. For the latter, all of the men and women in the 31 to 49 year old age group were active in some way in Luiza, while 100% of the women but only 50% of the men participated in Dibaya. For the 16 to 30 year old group, 83% of the women in Luiza compared to 50% of the men were involved in pondwork. The reverse situation prevailed in Dibaya where 100% of the men worked on ponds versus 80% of the women in that age group. In Kananga, within the 16 to 30 years old age group, 75% of the males in initial adopter households and 78% of them in S+D households were involved in pondwork. Female participation in pondwork was similar in I households for both the 16 to 30 and the 31 to 49 age groups. Moreover, the level of female participation was much higher in I households than in S+D ones--in the 16 to 30 age group, 88% for I households versus 56% for S+D families; and in the 31 to 49 age group, 92% versus 60%.

Variation in the extent of participation between age groups in I and S+D households reflects differences in the mean ages of

FIGURE 8. PERCENT OF TOTAL AVAILABLE HOUSEHOLD MEMBERS PARTICIPATING IN PONDWORK BY SEX AND AGE



a/ Number in parentheses is total number of households surveyed in each category.

b/ $\bar{X}$ is the mean age of the principal fish farmer in each category.

c/ No men 50 years old or more were found in any of the households in this category.

the principal fish farmers for those categories. S+D households had fewer members over 49 years of age to draw on for pondwork.

The average supply of labor involved in pondwork shown in Table 36 was determined by multiplying the participation percentages from Figure 8 by the average number of persons found per household for each category. Values for the mean total number of persons involved in some pond-related activity ranged from 4.3 per S+D household in Dibaya to 7.5 per S+D household in Luiza. Kananga I households had a much smaller pool of adult labor to utilize in pond culture than did I households in Dibaya and Luiza. Only 55% of the "pond force" in Kananga I households was supplied by adult men and women, compared to 74% for those in Luiza and 67% of the I households in Dibaya. The average number of adult males and females per household involved in at least one of the pond operations was approximately the same across all categories.[15] Differences did exist, however in the extent of male and female participation when pond-related activities were examined separately.

In general, the delineation by gender of activities important for generating income was much more pronounced in Kananga than in the rural areas. In the latter, crop production was the principal activity and was often jointly engaged in by men as well as women. Moreover, male participation for I households in both Dibaya and Luiza was considerable and not limited solely to their involvement in clearing

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[15]The significant exception to this statement is the S+D category for Luiza. However, it is felt that the 3.2 adult women per household reported there was caused by the small sample size for this division (4 households) coupled with the high incidence of polygamy found in two of those households.

Table 36. Average Number of Persons Involved in Pondwork

Labor Supply	LUIZA I	LUIZA S+D	DIBAYA I	DIBAYA S+D	KANANGA I	KANANGA S+D
	(Number per Household)					
Males in Pondwork						
6-15 years old	0.9	0.8	1.8	0.4	1.5	1.1
>15 years old	2.1	1.5	2.5	1.5	1.7	1.9
Females in Pondwork						
6-15 years old	0.5	2.0	0.5	0.9	1.2	0.9
>15 years old	1.9	3.2	2.1	1.5	1.6	1.2
Total AVAILABLE POOL of Adult Labor	5.1	6.0	5.2	4.2	4.1	4.4
Total SUPPLY OF LABOR in Pond Culture						
Adults Only	4.0	4.7	4.6	3.0	3.3	3.1
Adults plus Children	5.4	7.5	6.9	4.3	6.0	5.1

fields. Significantly lower percentages of joint male-female participation in income-earning activities were found in urban than in rural households (see Table 37). In the city, the man or woman would be involved separately in wage employment or trading, but rarely together. The male head alone was responsible for earning the cash generated by the most important activity in 65% of the pond-operating households in Kananga compared to 25% of those in Luiza and only 9% in Dibaya. A high proportion of rural men 16 to 30 years old were involved in crop production, but this was not true for urban youth. While the male head of the household in Luiza controlled the dispensing of cash for the household, numerous instances were encountered in both Dibaya and Kananga where the female head

Table 37. Proportion of Household Members Performing the Most Important Income Generating Activities

(90 Initial and Secondary Adopter Households Surveyed, 1983)

Activity in Zone	Male Head Alone	Wife Alone	Male + Wife or Wives	Male + Wife & Children	Male + Son(s)	Other[a]
Most Important:						
Luiza	25	6	56	6	0	7
Dibaya	9	0	54	18	4	15
Kananga	65	22	6	2	2	3
Second Most Important:						
Luiza	69	0	19	0	0	12
Dibaya	19	10	33	24	5	9
Kananga	48	32	4	2	2	12
Third Most Important;						
Luiza	43	7	28	0	0	22
Dibaya	29	18	12	17	6	18
Kananga	59	17	14	3	0	7
Fourth Most Important:						
Luiza	100	0	0	0	0	0
Dibaya	50	0	8	25	0	17
Kananga	62	12	0	0	25	1

[a]Other includes son(s), daughter(s), daughter-in-law(s), younger brother(s) and sister(s), alone or in combination.

was either completely or jointly in charge of guarding and spending any income earned.

Clearing and Construction

The amount of labor necessary to prepare a site for construction was highly variable, depending on such factors as: 1) the degree of forestation, 2) the presence of palm trees, 3) the type and water content of the soil, and 4) the distance from the location of the pond to the source of water. The estimates of 1.0 to 1.12 man-days per are for clearing fields are representative of the lower end of the range for site clearing associated with pond construction.[16] While the overall surface area cleared is much less than for annual cropping activities, it is much more thorough in that stumps must be uprooted as well. When asked to cite the most important problem encountered in building the ponds, 54% of initial adopters in Luiza responded that it was the hard work entailed in uprooting palm trees. Forty percent of the initial adopters in Dibaya and 22% of those in Kananga felt likewise. The removal of a single palm tree could add anywhere from two to four man-days of labor. The range in the number of palm trees found per are for the in-depth survey sample was zero to five.

Pond sites were most easily cleared when the vegetation could be effectively dried and burned, either during the dry season or during minanga--a two week period of diminished rainfall normally

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[16]Estimates for Zaire in general as determined by INEAC (1958) and the World Bank (1983).

occurring in January. Clearing was predominantly a male activity. All males in the 31 to 49 age group in I rural households were involved in site clearing, as were 86% of those in the corresponding age group in Kananga (see Figure 9). There was also substantial participation by younger men in the 16-30 year old I category. The corresponding figures were 41% in Luiza, 52% in Dibaya, but only 30% in Kananga. Initial adopter males in Dibaya received the greatest amount of assistance from women in the 31 to 49 year old group (57%), especially their wives. Women were principally active in the cutting of smaller trees and the hauling of cut materials into piles. It was reported that older women (>50) in I households did not assist in clearing in any of the three areas, but limited involvement of younger women (<31 years) was observed in the rural areas.

A somewhat different situation was reported in S+D households, except with regard to adult male participation in clearing for all pond-operating households in Luiza. Figure 10 shows that male secondary adopters and drop-outs <31 years old in Dibaya and Kananga had much higher levels of participation than those in I households (60% versus 30% in Kananga; 77% versus 52% in Dibaya for the 16 to 30 year olds). The opposite was true for men in the 31 to 49 age group (75% for S+D versus 86% for I in Kananga; 50% versus 100% in Dibaya). Although

FIGURE 9. PERCENT PARTICIPATION IN INITIAL ADOPTER HOUSEHOLDS BY SEX AND AGE IN CLEARING AND CONSTRUCTION

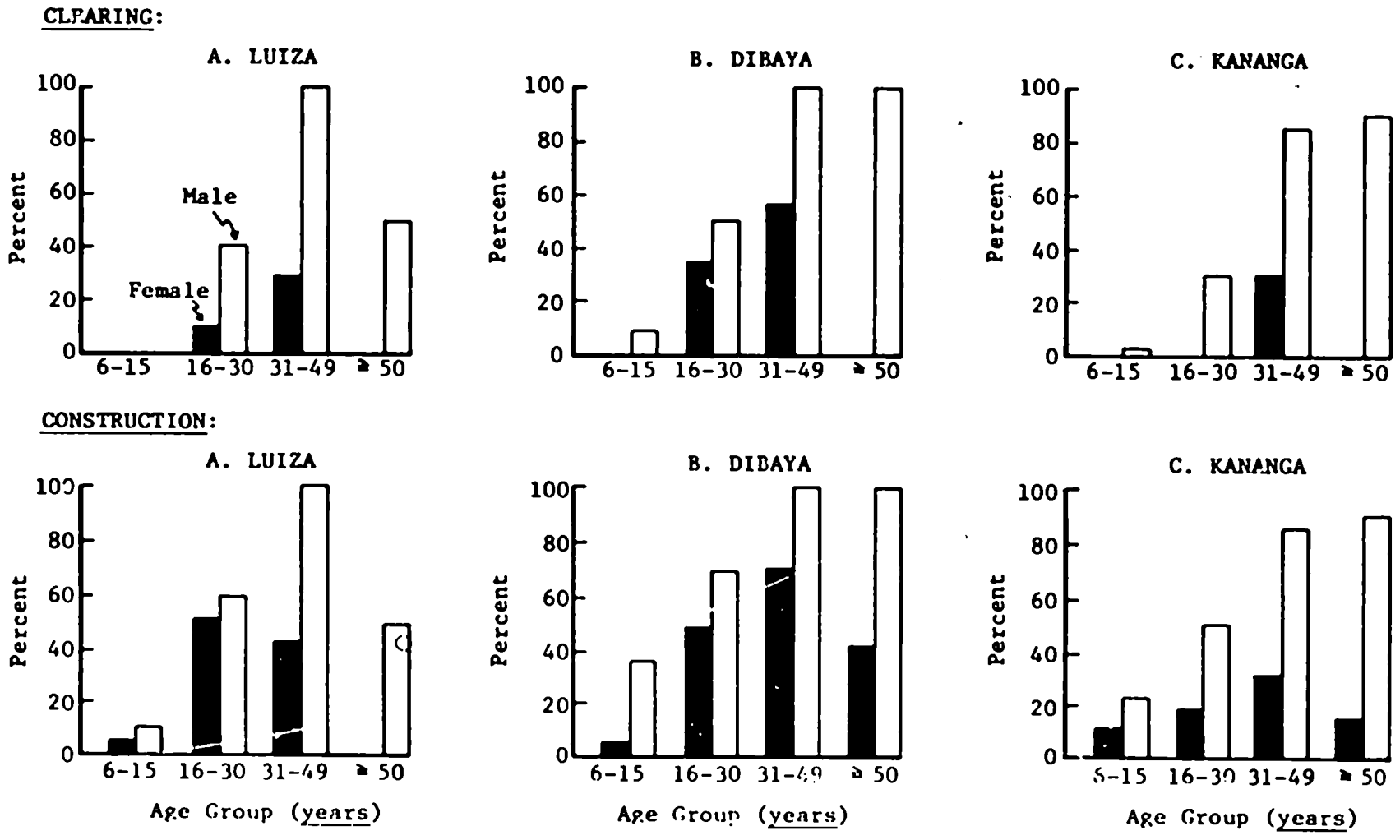
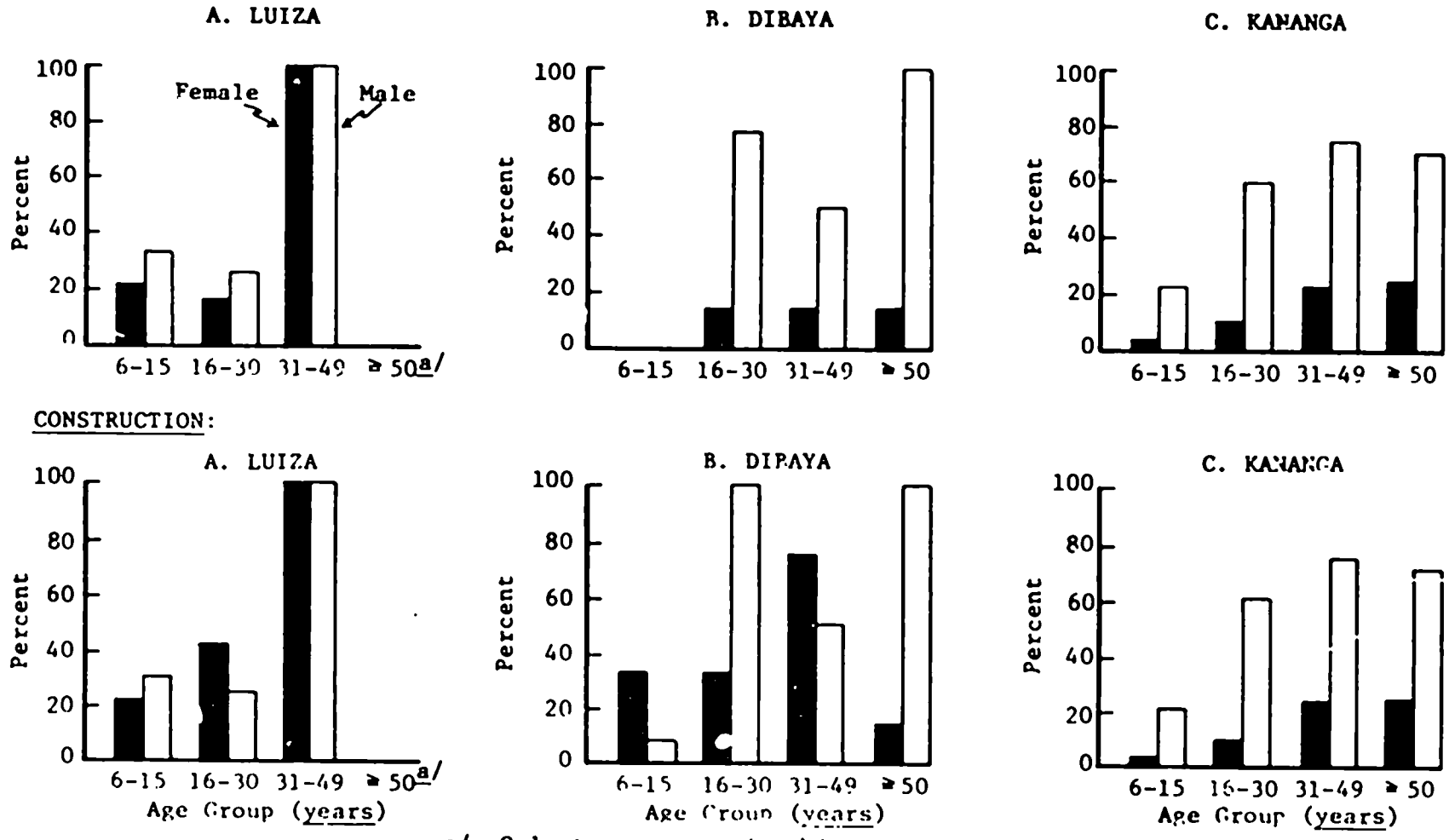


FIGURE 10. PERCENT PARTICIPATION IN SECONDARY ADOPTER AND DROP-OUT HOUSEHOLDS BY SEX AND AGE, IN CLEARING AND CONSTRUCTION



a/ Only two persons in this age group.

male participation did not alter, that of females in Luiza S+D households was much higher than was found in I households.[17]

Dikes in sandy soils could be constructed fairly rapidly in contrast to those in heavier clay soils encountered in Luiza, especially when the latter were wet. Twenty-three percent of initial adopters in Luiza reported that they had suffered severe back problems or muscle strain during pond construction, whereas only 13% of the initial adopters in Dibaya, and 6% of those in Kananga had similar problems. Initial adopters in Luiza encountered fewer technical problems getting their clay dikes not to leak (15% reported having problems) compared to farmers having to deal with the sandier Kananga soils where 33% of them indicated that it had been difficult to get their dikes to seal initially. Farmers surveyed in Dibaya did not report any major difficulties of that nature in the construction phase.

The building of the ponds, like that of clearing, was predominantly a male activity. However, female participation was significant among rural women 16 to 49 years of age. For example, 71% of the women in the Dibaya initial adopter sample 31 to 49 years of age participated in pond construction. The comparable figures were

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[17]Although the degree of participation in clearing a pond site was similar to that reported for rural males in crop production, it was quite different for women. A much greater involvement of adult women from initial adopter households not in the 31-49 age group was found for clearing fields than for pondwork. In many cases, rural women were entirely responsible for the clearing of the savanna fields, in addition to assisting their spouse in the forest. In Kananga, much greater female involvement in clearing fields was seen across all age groups than was reported for pondwork, while the reverse situation held for men.

43% in Luiza, but only 31% in Kananga. Even higher percentages for female participation were reported in rural S+D households for this age group. While most men dug with a shovel, women usually employed a hoe and/or hauled dirt in baskets or basins.

The market for hired agricultural labor in both Luiza and Dibaya was thin. The reported incidence of assistance in pond construction is shown for all categories in Table 38. Although the majority of farmers in all areas received some sort of assistance in constructing their ponds, approximately a quarter of all fish farmers in Kananga built ponds completely on their own. The most popular practice among rural initial adopters was to arrange to have anywhere from two to seven neighbors and/or relatives assist in clearing or construction during an intense period lasting from several days to a couple of weeks. Sixty-nine percent of the initial adopters in Luiza "paid" this labor in food and drink, as did 61% of the initial adopters in Dibaya. Cash payments in Kananga were more prevalent than in the rural areas, but S+D farmers in all areas relied more heavily on immediate family labor than hired labor. It should be noted that payment for services rendered was rarely arranged on a per day basis. Usually a price for the entire job would be negotiated beforehand, a portion of the salary being paid out as the work was undertaken and the remainder upon completion of the pond.

Table 38. Reported Incidence of Assistance in Pond Construction

(Percent of Total Households Surveyed in Each Category)

Area	No. in Category	Received Some Assistance	Paid for Assistance in: Cash	Food and Drink
Luiza				
I	13	92	15	69
S+D	4	100	50	25
Dibaya				
I	15	100	13	61
S+D	12	75	0	0
Kananga				
I	18	72	33	11
S+D	54	74	15	3

Only a handful of farmers could recall what they paid for hired labor; estimates of person-days involved in construction were even more uncertain. The average payment per person hired varied considerably: it was reported to be Z77 by initial adopters in Dibaya; Z574 by initial adopters in Kananga; and Z607 for those in Luiza. S+D households reported lower average payments than found in I households (Z208 for Kananga and Z120 in Luiza). No S+D farmers in Dibaya recalled making cash payments at all. Payments in food and drink in the rural areas generally entail providing some kind of meat. Since meat is expensive several farmers mentioned that "engaging" help for pond construction was costly. Yet only 7% of the initial adopters in Dibaya cited insufficient labor as being the major constraint they had encountered in constructing their ponds. The same response was given by 6% of the initial adopters in Kananga, and was not mentioned by those in Luiza. Ten percent of the rural secondary adopters cited that it was expensive to hire labor, while those

in the urban area did not consider it as the major problem they faced in pond construction.

In summary, though the clearing of the site and the building of the pond is principally in the adult male domain, the substantial contribution by adult rural women less than 50 years of age should not be overlooked. Both activities are time-consuming, but can be regarded as a long-term investment of energy since repeated annual clearing as in crop production is not necessary. Most farmers prefer to construct ponds during periods of low rainfall which coincide with lulls in agricultural work.[18] These times also coincide with school vacation periods when supplementary family labor, particularly that of sons, is more available. The physical intensity of the work probably restricts participation in pond culture in the forested rural areas to healthier individuals. Relatively few farmers consider insufficient labor to be the most significant problem they encountered in constructing their ponds.

Composting, Feeding and Maintenance

The significance of composting and feeding towards enhancing yields has already been discussed. The responsibility for performing those activities will be the focus of this section.

Composting duties were usually undertaken by the principal fish farmer in the household. The assistance of older women in rural households was significant, particularly in Dibaya. Fifty-seven

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[18]Luiza farmers, however, are usually restricted to digging during the first half of the dry season as the clay soils become too hard to penetrate thereafter.

percent of the women in the 31 to 49 year old age group in I households in Dibaya were involved in composting, as were 75% of those from S+D households (see Figures 11 and 12). The contribution made by I women in this age group was less in Luiza (29%) and Kananga (38%). Women's activities in composting were often centered around transporting manures and wastes, and occasionally in gathering leaves. Men were almost always responsible for cutting the grass on the dikes, as activities requiring the coupe-coupe fell within their domain. Often such cut material was added to the compost pile. Consequently, the males of the household performed most of the work associated with composting.

Labor divisions with regard to supplementary feeding were a different story. Table 39 summarizes the data pertaining to responsibility for feeding the fish in initial and secondary adopter households. Fish farmers who were also heads of households took sole responsibility for feeding the fish in about a quarter of the I households in Luiza and Kananga, and in only 8% of them in Dibaya. Among secondary adopters, the male head of the household never was solely responsible for feeding the fish, and in 10% of the cases was not involved at all. Reliance on other family members was even more pronounced in urban secondary adopter households. In 29% of these households, the male head did not participate at all in feeding the fish and had sole responsibility in only 19% of those households surveyed.

FIGURE 11. PERCENT PARTICIPATION IN INITIAL ADOPTER HOUSEHOLDS BY SEX AND AGE IN COMPOSTING, FEEDING, AND MAINTENANCE

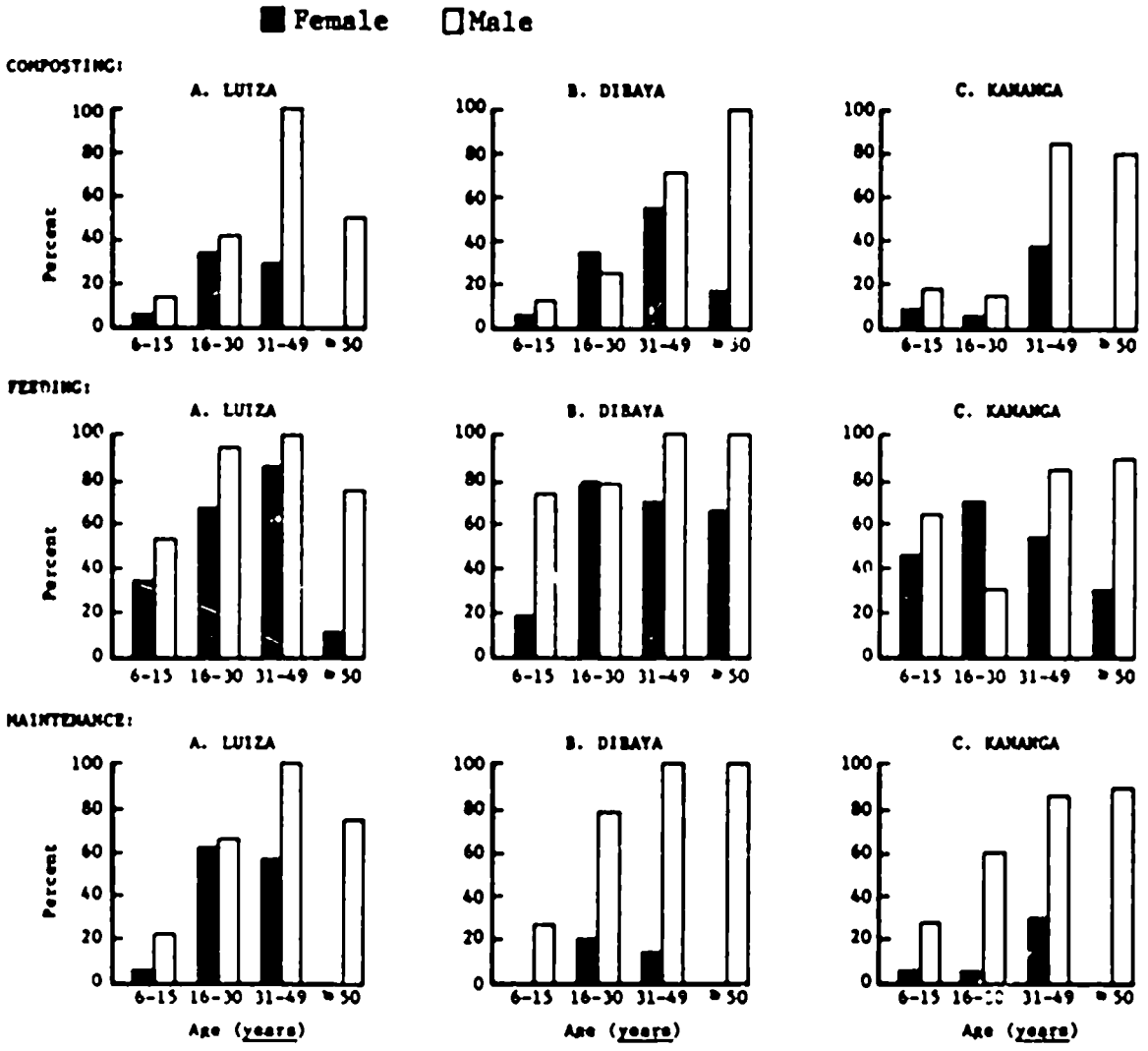
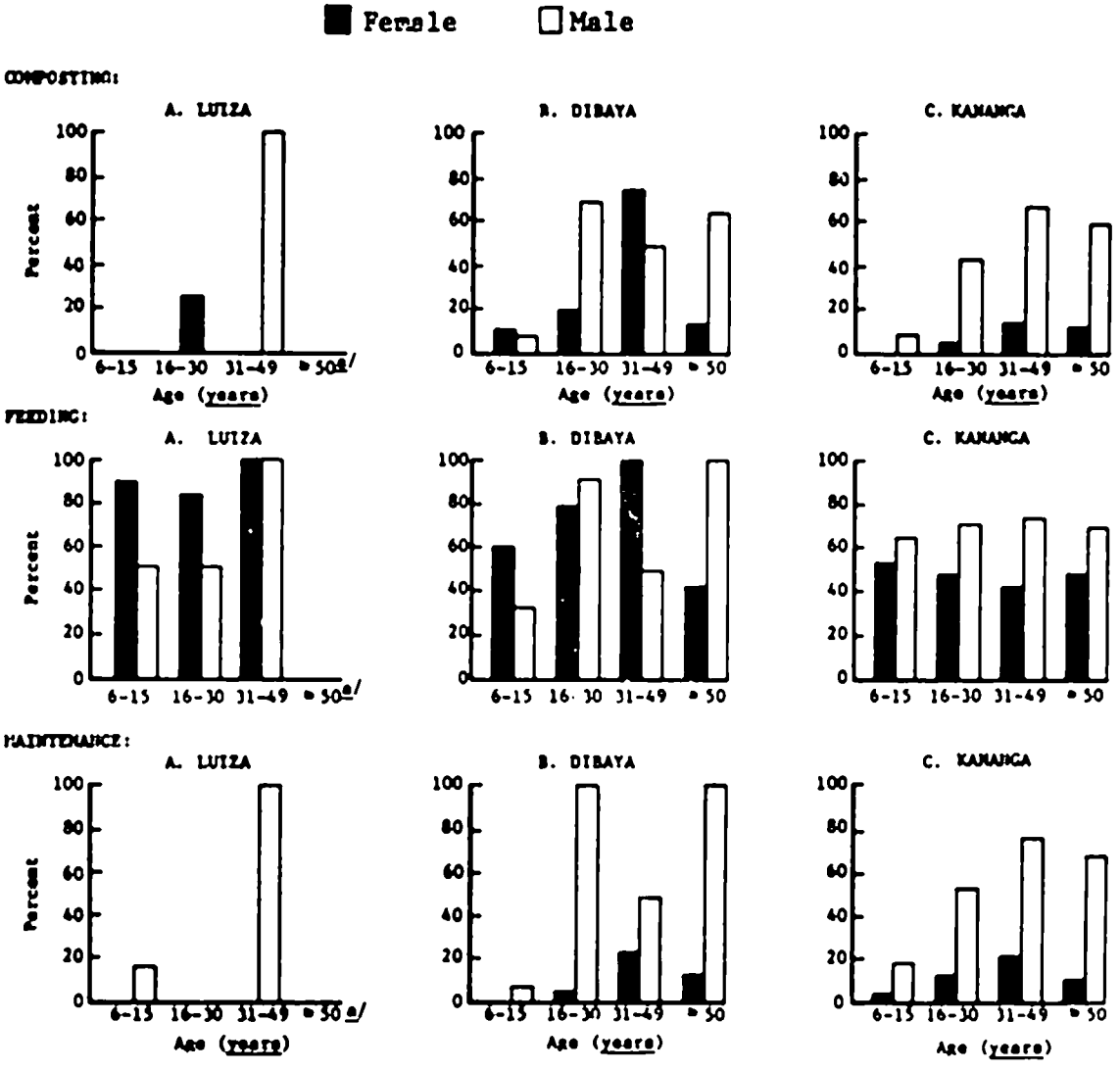


FIGURE 12. PERCENT PARTICIPATION IN SECONDARY ADOPTER AND DROP-OUT HOUSEHOLDS BY SEX AND AGE IN COMPOSTING, FEEDING, AND MAINTENANCE



a/ Only two persons in this age group.

Table 39. Persons Responsible for Supplementary Feeding

(Percent of Initial and Secondary Adopter Households Surveyed)

Person Feeding	INITIAL ADOPTERS Luiza	Dibaya	Kananga	SECONDARY ADOPTERS Rural	Kananga
Farmer (head) alone	23	8	22	0	19
Farmer (non-head) alone	0	0	0	0	3
Head female alone	0	0	0	0	3
Farmer + wife(ves) only	15	50	11	30	6
Farmer + children only	15	17	22	20	26
Whole family	31	25	33	30	19
Other	16	0	12	20	24
Male head NOT involved	8	0	6	10	29

Males of all ages were significantly involved in supplementary feeding in rural I households. The same held true in Kananga, except for males 16 to 30 years of age. Only 30% of these participated in feeding. Adult women in I households were heavily involved in feeding in all areas. In addition, among S+D households, more than 50% participation was reported among girls 6 to 15 years of age. The involvement of both children and adult women in supplementary feeding was much greater than in composting.

The dispersion of responsibility for feeding has some interesting implications. Extension services were geared towards training the principal fish farmer. Any information that goes to the rest of the family was transmitted by the farmer, except in certain families where other members were habitually present at the time of extension

visits. Families that shared responsibility on a continuing basis for feeding could counterbalance any declines in production that might occur as a result of absences of the principal farmer. This frequently happens because of illness, trade-related travel, attending funerals, or other agricultural work. Periods of illness can be of substantial length. Among the 11 urban initial adopter households interviewed in the in-depth survey, 90% of the heads of household had fallen ill during the year preceding the survey. The average total length of illness was 8.45 weeks for those who fell ill. Three of the 10 heads of households in the rural areas were unable to attend to their ponds during the preceding year because of illness, for an average period lasting 9.0 weeks.

Absences due to trade-related travel were not very significant for the principal male farmers in the 11 urban households. While only one of the Kananga farmers in this group had left the city during this period, over 50% of those in the rural group had left their villages to engage in trade or attend a funeral. The average annual length of absence for those farmers was 12.0 weeks. Bicycle owning farmers in Luiza, in particular, travel frequently to markets to sell crops, palm oil, soap, or salt, especially during the dry season when the clay roads are packed down.

There are several activities related to the maintenance of ponds that must be considered. These activities include repairing leaks in dikes and canal systems, planting and cutting grass, watching for damage caused by insects and predators, refurbishing a pond after a harvest, and replacing bamboo pipes. Men are primarily

responsible for most of these activities, especially cutting the grass. The amount of time spent repairing ponds either during the production period, or following a harvest, is a function of how well the pond was constructed in the first place. Harvesting a pond usually requires cutting the dike with a shovel. The pond should be constructed so that it will drain completely. In muckier soils, it is often necessary for the farmer to remove accumulated mud pockets during the post-harvest period so that fry do not survive.[19] Both urban and rural farmers reported figures for the amount of time needed to clean out and reclose the pond that ranged from one to four person-days per are. Agents recommended drying the pond bottom out for one to two weeks before restocking.

Time Required for Composting, Feeding, and Maintenance Activities

The limited data collected in the in-depth surveying of the 11 urban and the 10 rural households was used to construct plausible scenarios regarding the amount of labor time employed in composting, feeding and maintenance activities for a one-are pond. Person-day estimates shown in Table 40 assumed an average working day of 6 hours. The estimates for feeding and composting time include walking time to and from the ponds. Maintenance estimates do not include walking time as farmers would rarely travel to the ponds to work on them without feeding the fish as well.

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[19]Tilapia are noted for their ability to survive under adverse conditions. If all fingerlings are not removed at harvest time, overstocking of the pond will occur and the next harvest will be dominated by stunted adults.

Table 40. Estimates of Labor Time Necessary for Composting, Feeding and Maintaining a One Are Tilapia Pond

COMPOSTING AND FEEDING:	Range in Estimated Time Spent per Are			
	Low			High
Time Investment (Hours per Day)	0.25	0.50	1.0	2.0
Person-day Estimate for 6 month period	7.5	15.0	30.0	60.0
MAINTENANCE				
		Low		High
Time Investment (Hours per Week)		0.50	1.0	2.0
Person-day Estimate for 6 month period		2.0	4.0	8.0
Total Maintenance Estimate[a] (Average Person-days)		4.5	6.5	10.5

[a]Includes an estimated value of 2.5 person-days for post-harvest pond refurbishing

Initial adopters who fed supplementary feeds and did little composting would tend toward the lower end of the scale (0.25 hours per day) while those who fed leaves or lived farther away from their ponds would be towards the upper end. The most reasonable estimate for a good pond manager for weekly maintenance time would be one hour per week per are; two hours would be required if necessary to make frequent repairs to the pond due to poor construction. It should be emphasized again that these estimates are based on a small sample of recall data, and involved subjective judgements on the part of the author as to whose ponds were well-built and well-maintained.

Harvesting and Marketing

Harvesting and marketing of a pond of tilapia in the vast majority of cases took place in one day. Only a few urban households reported drying any fish from the harvest for later consumption. Thus, the scheduling of the harvest during a time of year when demand was high was an important factor for the majority of farmers. Both male and female members of initial adopter households were heavily involved in harvesting and marketing. Female participation, however, was substantially less in the S+D households in Kananga and Dibaya than in the I households for those areas (see Figures 13 and 14).

It was not possible to collect labor input data by direct observation in the rural sector; however an attempt was made to corroborate reported degrees of participation in pond activities with time allocation measurements made in Kananga. Nine valleys in Kananga were observed over 44.5 different half-day periods between October 1983 and February 1984.[20] Both initial and secondary adopters were present in these valleys. As the ponds in this area had already been built, no instances of clearing or building activities were observed. The amount of time spent on activities in the valley as well as the sex of the individual performing the operation was recorded. A total of 607 hours of time were recorded as being spent in activities in the valley, of which 86% were related to the ponds (see Table 41). Of these, harvesting consumed the highest percentage of person-hours spent at the ponds (43%).

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[20]All these observations were made by the same enumerator.

FIGURE 13. PERCENT PARTICIPATION IN INITIAL ADOPTER HOUSEHOLDS BY SEX AND AGE IN HARVESTING AND MARKETING OF POND FISH

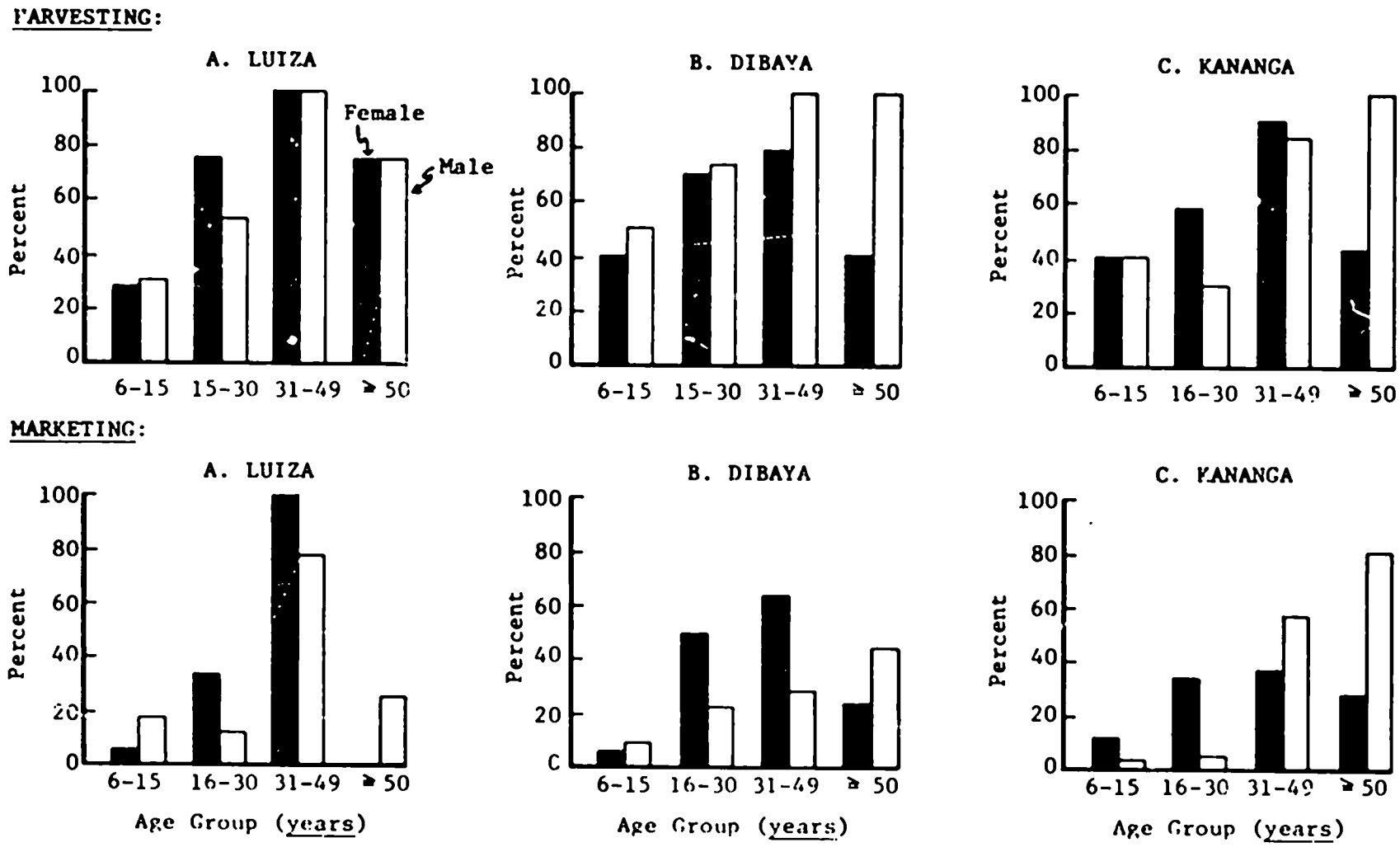
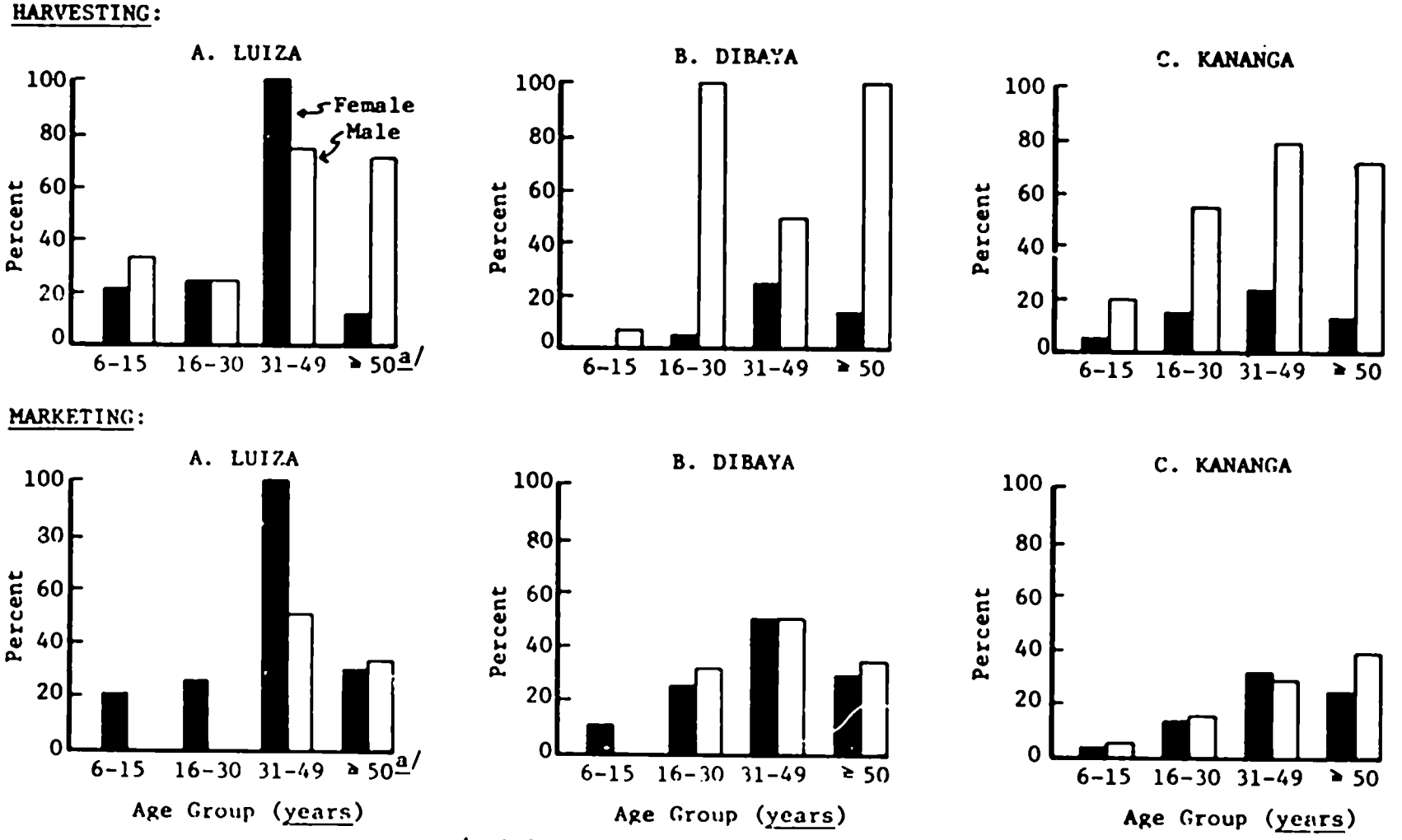


FIGURE 14. PERCENT PARTICIPATION IN SECONDARY ADOPTER AND DROP-OUT HOUSEHOLDS BY AGE AND SEX IN HARVESTING AND MARKETING



a/ Only two persons in this age group.

Table 41. Time Allocation Among Various Activities in Nine Kananga Valleys

(Observed Activities from October 1983 to February 1984)

Activity	Hours of Observed Activity	Percent of Total hours Observed	Percent of Pond-Related Activities
Pond-Related			
Composting	17.2	2.8	3.2
Feeding	36.4	6.0	7.0
Planting Grass	23.2	6.1	7.1
Cutting Grass	43.2	7.1	8.2
Fixing Dikes	67.9	11.2	13.0
Harvesting	225.2	37.1	43.1
Marketing	15.3	2.5	2.9
Selling Fingerlings	10.2	1.7	2.0
Fishing	85.4	14.1	16.4
Non-Pond Related			
Crops/Gardens/Palm Nuts	46.0	7.6	0
Fetching Water	30.0	4.9	0
Bathing	7.2	1.2	0

The percentage of time allocated to such maintenance activities as planting and cutting grass and dike repair (28% in total) was much higher than that devoted to feeding.[21] Feeding accounted for only 7% of total time and was almost exclusively done by males (see Table 42). Fishing by children also accounted for a significant total of all pond-related activity (16%). A high proportion of total time spent by women in the valleys was in the non-related activity of looking for drinking water from adjacent sources.

[21]The opposite relation was expected. However, the presence of a large number of secondary adopters who fed more irregularly and would probably need to repair their dikes frequently influenced the results. In addition, time devoted to gathering feeds outside of the valley would not have been recorded.

Fourteen harvests were observed and recorded during the time allocation study. The average number of persons significantly involved in each harvest was 5.7, 49% of whom were female. The division between those participating who were under 16 years of age and those who were older was approximately equal. The average harvest lasted 3.0 hours. The size of the ponds harvested ranged from approximately 0.5 to 2 ares in size. An average of 11.2 person-hours were spent per are in the harvesting process.

Table 42. Relative Contributions of Individuals By Sex and Age in Major Pond Activities

(Valley Floors in Kananga, Oct. 1983-Feb. 1984)

	Children	Males		Females	
Activity	<6 yrs. old	6-15	>15	6-15	>15
Pond-Related	(Percent of Total Hours in Each Activity)				
Composting	3.5	53.2	40.4	2.9	0
Feeding	0	40.8	58.1	0.7	0.4
Planting Grass	0	51.7	41.2	0	7.0
Cutting Grass	0	33.0	67.1	0	0
Fixing Dikes	0.2	29.4	66.7	0	3.7
Harvesting	0	28.2	22.9	17.8	31.1
Marketing	0	0	45.7	11.9	42.4
Selling Fingerlings	0	14.6	37.4	14.6	33.4
Fishing	1.6	52.3	43.0	1.8	1.3
Non-Pond Related					
Crops/Gardens/ Palm Nuts	2.1	25.1	11.7	10.8	50.3
Fetching Water	0.9	2.5	3.9	40.3	52.7
Bathing	55.6	6.9	2.4	14.7	20.4

Although fish marketing is typically viewed as a woman's activity, adult men >30 years old in I households in Luiza and Kananga also were heavily involved in the marketing process. Data from the most

recent harvest indicated that 44% of the male fish farmers in I households in Luiza sold the fish themselves, compared to 29% of them in Kananga, and only 12% in Dibaya. (see Table 43). Respondents indicated that the male fish farmer was in charge of the majority of sales of fish in S+D households. This conflicted with the more detailed household data for Luiza and Dibaya which reported higher percentage participation by rural women than men in marketing the fish. Rural women were also more involved in fish sales that were their urban counterparts.

Table 43. Marketing of Pond Tilapia: Who Sold the Fish From the Most Recent Harvest

Person Who Sold Fish	INITIAL ADOPTERS			SECONDARY ADOPTERS		DROP-OUTS	
	Luiza	Dibaya	Kananga	Rural	Kananga	Rural	Kananga
	(Percent of Respondents Who Sold Fish)						
Farmer being Surveyed	44	12	29	50	8	60	28
First Wife	22	50	36	25	42	20	43
Farmer + Wife	0	0	0	25	8	0	0
Daughter(s)	11	12	14	0	17	20	0
Wife + Daughter	11	0	14	0	4	0	0
Younger brother	11	12	0	0	0	0	0
Son	0	0	0	0	8	0	13
Daughter-in-law	0	12	0	0	0	0	0
Other	0	0	7	0	13	0	14

Summary and Conclusions Regarding Labor Use

The picture which emerges regarding labor use in pond culture is that it is hazardous to make broad generalizations regarding either the division of functions between the sexes or the total amount of labor input necessary for good manangement. Older women, particularly in the zone of Dibaya, are significant contributors to the "male" domain of construction activities. Recurrent absence of the male head of the household from the ponds, whether due to illness or trading ventures, emphasizes the necessity of recognizing the role played by women and children in feeding pond fish. The typical assignation of the dominant role in harvesting and marketing to women also is subject to variation among areas. Men are significantly involved as well, especially with regards to the marketing of fish in Luiza.

From the data gathered in this study it appears that there is no critical shortage of labor for clearing, construction, harvesting, or marketing activities. The requisite amount of labor for completing these endeavors can be generated on a short-term basis, albeit often at significant expense. The labor input needs associated with composting, feeding and maintenance are highly variable as they depend upon adequate human and feed resources being available on a year-round basis. Fortunately, a well-built pond can withstand long periods of management neglect which ensures the continued existence of pond culture in the short-run.

Data limitations make it impossible to compare with any degree of precision the amounts of labor use necessary for fish versus

crop production. The relative worth of the two activities can be approximated to a certain extent by employing labor figures determined during colonial times. Table 44 compares the returns to land and labor from the production of one are of manioc, maize, or peanuts with that from a well-managed pond system. In estimating the amount of time needed to produce 25 kilograms of tilapia from a one are pond it was envisaged that anywhere from 15 to over 90 person-days would be required to construct the pond and canal system. The lower figure would correspond to a non-forested, sandy area that had a nearby source of water. The opposite extreme would be more representative of conditions found in Luiza--where forested valleys and clay soils predominate. When these values were combined with the high and low estimates of labor time for composting, feeding and maintenance[22] plus an average value of 2.4 person-days for harvesting and marketing, total labor input ranged from a low of 29.4 to a high of 162.9 person-days per are. The low labor input scenario corresponds to a farmer who developed a non-forested site, had access to supplementary feed and a ready supply of composting materials. The high labor input case reflects less favorable conditions for pond construction, a reliance on leaves as the primary feed, and the need to transport composting materials a considerable distance.

Following the initial six month production cycle, the substantial labor input for clearing and construction can be dropped. It is not unreasonable to speculate that construction time for any additional ponds would be lower than that for the first as the canal system

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[22]Values generated in Table 40.

Table 44. Comparative Return to Land and Labor of a Well-Managed Pond Versus Crop Cultivation, December 1983-January 1984

	CROP PRODUCTION			TILAPIA PRODUCTION[a]			
	Manioc	Maize	Peanuts	Initial		Subsequent	
				Low	High	Low	High
Labor Input[b] (Person-days per are)	7.3	2.5	4.2	29.4	162.9	14.4	73.9
Average Yield[c] (Kgs. per are)	87.0	7.4	5.4	25.0	25.0	25.0	25.0
Gross Return to One ARE of Production (Zaires)[d]							
Rural Sector	487.2	37.0	37.8	1000	1000	1000	1000
Urban Sector	1444.2	85.8	101.5	1125	1125	1125	1125
Return to LABOR (Zaires per Person-day)							
Rural Sector	66.7	14.8	9.0	34.0	6.1	69.4	13.5
Urban Sector	197.8	34.3	24.2	38.3	6.9	78.1	15.2

[a]Initial production period includes labor requirement for pond construction. Labor estimates were derived from answers to the more in-depth survey. Fifteen person-days per are was the lowest and 90 days the highest of the recall values reported for site clearing and pond construction in initial adopter households. Low and High represent the range of possible labor inputs given the different resource bases available to the farmers.

[b]Crop production values are from man-day requirements for one hectare of production for Zaire as reported in INEAC (1958). The high value for manioc is due to the extensive amount of labor that goes into post-harvest treatment.

[c]Yields for crops were the mean value of yield figures for all Zones presented in Table 6.

[d]Based on prices gathered in all areas during December 1983 and January 1984. Prices are for peanuts in shells, dried and peeled (but not ground) manioc, and decorticated maize. The representative value of Z40 was used for fresh tilapia in the rural sector, Z45 for the urban area.

is already present. The same logic does not hold with respect to feeding time in the rural sector where any increase in the number of ponds built augments the likelihood of encountering a labor shortage for the collection of sufficient feedstuffs.

As can be seen in Table 44, tilapia production is a labor intensive operation that provides a high gross return per unit of land in both the urban and rural sectors. In the rural areas, tilapia production gives lower returns to unit labor input than does maize or peanut production during the pond's first production cycle if the farmer is required to spend a large amount of time collecting composting material and feed. In subsequent years, the return to labor from tilapia production would be comparable to or surpass that to be gained from maize or peanuts. This return to labor from fish production is much lower than that from manioc in both instances but a substantially longer production period is required to cultivate one crop of manioc (18 to 24 months vs. 6 months for tilapia).

Because of the higher prices received for crops in the urban sector, the unit return to labor for pond culture cannot compete with that from crop production when a high labor input is needed for feeding, composting and maintenance tasks. However, the higher return per unit land for tilapia culture takes on added significance in the urban setting as many individuals do not have access to sufficient land suitable for crop production. The potential return to labor is greater than that from peanut and maize production in both the initial and subsequent years when farinaceous by-products are available.

Social Costs

So far the emphasis of this discussion on costs has been on technical problems and labor use. Yet equal in importance to these is the incidence of theft. When farmers were asked to name the most significant problems they encountered in raising fish, theft ranked high in both the rural and urban sectors. Although there is some variation among the different categories of adopters (as shown in Table 45), overall, theft was the second most serious constraint faced by farmers, the first being that of obtaining sufficient amounts of feed.

The incidence of theft is closely interrelated with the concept of lukinu, or jealousy. In the Kasaian context, lukinu is an expression of jealousy in the broadest sense. It incorporates the physical acts of stealing and poisoning fish in addition to the more passive forms of verbal criticism or unwillingness to provide assistance. While approximately a third of both the initial and secondary adopters reported never having problems that resulted from the jealous feelings of others, the percentages were much lower for their urban counterparts (11% for I; 18% for S).[23] The most frequently encountered expressions of lukinu are presented in Table 46. Together they represent the "social costs" that many farmers must pay at one point or another for engaging in a new activity.

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[23]Problems with jealousy and its expression vary considerably from village to village. The extension agent based in another part of Luiza (Sambuyi) reported a much higher incidence of pond poisoning than that indicated for the Mankanza/Tulume research area.

Table 45. Most Important Problem Encountered in Raising Fish

(Percent of I and S Households Citing Each Response)

INITIAL ADOPTERS		SECONDARY ADOPTERS	
Luiza:		**Rural:**	
Excessive theft	(31)	Obtaining enough fish food	(50)
Lack of tools	(23)	Predators: birds & iguanas	(20)
Feeding fish is hard work	(15)	Excessive theft	(10)
Lack of sufficient labor	(8)	Buyers want fish on credit	(10)
Poor yields	(8)	Too many small fish at harvest time	(10)
Difficult to haul manure	(8)		
Lack of sufficient time to work on ponds	(8)		
Dibaya:			
Obtaining enough fish food	(27)		
Excessive theft	(20)		
Predators: birds & iguanas	(20)		
Lack of tools	(13)		
Lack of manure	(7)		
Poor yields	(7)		
Work is too hard	(7)		
Kananga:		**Kananga:**	
Obtaining enough fish food	(55)	Obtaining enough fish food	(50)
Lack of tools	(17)	Excessive theft	(26)
Excessive theft	(11)	Lack of tools	(12)
Hassles from local officials	(6)	Poor yields	(6)
Problems with wild fish	(6)	Predators	(3)
Illness	(6)	Lack of sufficient labor	(3)

In part, these costs reflect a traditional means of resource redistribution within the society itself. A farmer who has a successful harvest is expected to share the fruits of his or her labor with other members of the extended family, whether or not they assisted the individual in building or managing the ponds. The prosecution of minor theft by fishing is often not carried out as many of the thieves are members of the same clan or even from the immediate family. The latter case was particularly evident in Kananga, where several farmers reported that their own children had been observed selling fish to neighbors while they were at work.

Table 46. Prevalent Forms of Jealousy Encountered by Initial and Secondary Adopter Households (Percent of Total Households Citing Each Response)

	INITIAL ADOPTERS			SECONDARY ADOPTERS	
Response	Luiza	Dibaya	Kananga	Rural	Kananga
Steal fish	15	13	28	30	41
Want fish for free harvest time, but won't assist in raising them	15	26	11	10	3
Criticize me	8	7	22	30	24
Poison fish	8	6	6	0	0
Create problems with government officials so I'll be taxed	0	7	17	0	6
Believe I receive benefits from extension agent that they can't get	0	7	5	0	0
Other	0	0	0	0	6
No problems with jealousy	31	27	-	30	18

Though the decline in yield caused by periodic fishing can be substantial, the more severe situation of the complete draining of the pond by thieves was uncommon, but not unheard of. Fish farmers in the urban area who wanted to publicize their harvest date to attract a larger clientele subsequently would be obligated to sleep near their ponds to avoid massive theft as the harvest date approached.

The incidence of pilfering is also tied to the farmer's social relations with the community as a whole. Those who are ostracized for other reasons or are embroiled in a family dispute probably would be subject to retribution by theft. From another standpoint, the tilapia harvest can be conceptualized as a cost-effective means of meeting one's social obligations. Several farmers in Luiza noted that they always tried to harvest a pond at holiday time because

then they would not be obliged to buy large quantities of more expensive kinds of meat. The multitude of individual fish of various sizes available at harvest time simplifies the distribution process among friends and relatives.

Theft remains one of the most serious constraints to long-term sustainability of pond culture. Increased surveillance of the ponds or the use of fetishes are about the only ways in which the problem can be combatted. Relaxed surveillance due to frequent absences from the village and deaths in the family often encourages pilfering by others. Fifty percent of the drop-outs surveyed in Kananga stated that excessive theft was the primary reason they abandoned their ponds (see Table 47). Though competition for labor time between fish and crop production was a more important consideration for rural drop-outs, 14% cited theft as the principal reason for quitting, with 43% reporting that it was the second most significant cause of abandonment.

Table 47. Reasons for Abandoning Fish Pond Culture
(Percent of Total Drop-Out Households Surveyed)

	RURAL		URBAN	
Primary Reason	Insufficient time available to work on ponds	(43)	Excessive theft	(50)
	Excessive theft	(14)	Lack of sufficient fish Food	(15)
	Other*	(43)	Conflicts with neighbors or local authorities	(10)
			Other*	(25)
Second Reason	Excessive theft	(43)	Poor production	(25)
	Illness	(28)	Excessive theft	(10)
	Other*	(29)	Heavy rains broke dikes	(10)
			Insufficient water	(10)
			Other*	(45)
Other* Reasons:	Conflict with Neighors or local authorities; Poor production		Insufficient Labor to help on ponds; Work on ponds is too hard; Lack of tools; Extension agent stopped visiting; Insufficient time available	

Several attempts to collectively tackle some of the social and variable costs inherent in pond culture were made by farmer "committees." The formation of these groups was initiated by the farmers' themselves or through the encouragement of the extension agent. Nine farmer groups were encountered in the research areas, eight of which were in Kananga, the remaining one in Dibaya. The principal benefit to farmers participating in such groups in their early stages was to have a forum for discussing common problems and make arrangements to visit pond operations belonging to other individuals. Over time, the main function of most groups in Kananga evolved into protecting farmers from taxation attempts by local officials. Three years after their inception, only three of the eight groups in kananga continued to meet on a regular basis. Two of them occasionally purchased brewery waste together, and one was cooperatively managing a 7 are pond on a semi-intensive basis. The principal focus of the Dibaya farmer group had been on assisting each other in constructing individual pond operations. Once that had been completed, the group only met on an irregular basis.

The sustainability of large (>15) farmer groups in Kasai Occidental would appear to be limited, mostly due to the hesistancy of individuals to contribute to a joint endeavor when their own personal resources are so limited. This reluctance is accentuated in urban areas by the distrust farmers have of those coming from different areas of the Kasais. Smaller groups consisting of members of the same village or extended family would probably be the most cohesive unit to work with in a group framework. The opportunities for this type of extension

work are limited by the considerable distances which often separate individual pond operations.[24]

In summary, when all of the land, material, labor and social costs are taken into account, five factors emerge as essential criteria for ensuring long-term sustainability. These are:

1) the building of ponds that can withstand heavy rainfall in well-selected sites,

2) self-sufficiency in fingerling supply,

3) stable, good health for the principal fish farmer,

4) the lack of excessive theft, and

5) the existence of an adequate labor supply for feeding the fish or the availability of inexpensive supplementary feeds.

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[24]The nature of farmer groups can vary from area to area. Some groups established in Bandundu Region have been meeting on a regular basis for several years.

VI. Harvesting and Marketing: Additional Considerations

Marketing factors can seriously affect the profitability of the pond enterprise. The demand for fresh tilapia is largely determined by two exogenous factors over which the farmer has little control: the relative prices of alternative protein sources and consumer preferences. Moreover, given that the harvesting and sale of tilapia usually occur in one day, the choice of when to harvest takes on added significance.

In the page which follows, the results of the survey pertaining to selling activities are reported. The influence of consumer preferences and relative prices are discussed in a second section. The third section examines factors related to the timing of harvest. In the final section, the advisability of smoking fresh tilapia for the urban market will be analyzed.

The inelastic nature of the supply from a single harvest can affect the price received by a farmer in one of two ways. If the quantity produced is small (<10 kgs., for example) the farmer generally has no difficulty selling the entire amount for a good price within the environs of his or her own home. This individual may choose to go to the market in the hope of receiving a better price than that which could be demanded from family or friends, or to sell any surplus that remains once the localized demand has been satisfied.

Farmers were asked to report where the sale of fish from their most recent harvest took place in order to have an indication of general patterns. Table 48 shows that none of the Luiza initial adopters sold their fish in a formal market--almost all of the sales were made at pondside or on the farmer's own parcelle. Sixty-two

percent of the initial adopters in Dibaya sold their fish at a market less than 5 kilometers away from their home, while sales made by the Kananga initial adopters were somewhat more evenly divided between home and market.

Table 48. Marketing of Pond Tilapia: Location of Sale of Fish From the Most Recent Harvest

Location:	Market <5 kms from pond	Market >5 kms from pond	Pondside &/or on parcelle	Parcelle + Market <5 kms from pond	Walked around village	Other[a]
	(Percent of Households that Sold Fish)					
Initial Adopters:						
Luiza	0	0	78	11	11	0
Dibaya	62	0	38	0	0	0
Kananga	47	0	40	0	0	13
Secondary Adopters:						
Rural	25	0	50	0	25	0
Urban	60	0	24	12	0	4
Drop-Outs:						
Rural	0	20	80	0	0	0
Urban	14	0	86	0	0	0

[a]Includes fish sold by the side of the road and at the farmer's place of work.

Thus, farmers in Dibaya and Kananga who rely more heavily on public markets would have to be particularly cognizant of supply fluctuations of other kinds of meat and fish. Urban producers expecting large yields of tilapia normally arranged orders before the actual day of the harvest itself.

Relative Prices and Consumer Preferences

Often it is hard for the tilapia producer to be able to predict what competing meat, fish, and insect products might be available on the day the fish harvest takes place.[1] Obviously, if the alternative sources are abundant, the price of the fresh tilapia may have to be lowered.

The demand for fresh tilapia is relatively high because of its lower price per kilogram when compared to other meats and animal by-products such as milk and eggs. The low-income consumer benefits substantially from the sale of a fish that is anywhere from three to eight times cheaper than alternative animal protein sources. The prices per gram of protein of some selected foods can be compared for the three research areas (see Table 49). Among those products included in the market survey, manioc leaves were the most inexpensive source of protein available to consumers in Kananga and Luiza, and second only to seasonally available termites in Dibaya. The fact that the majority of rural pond operators reported eating more fish in the dry season than in the rainy season reflects the decline in leaf availability during this period. Most urban dwellers reported that there was no significant difference in their seasonal consumption of fish. Although tilapia cannot compete on a cost per kilogram basis with vegetable sources of protein such as peanuts and beans, the latter are susceptible to large seasonal fluctuations in supply.

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[1]Public urban markets operated daily. Rural farmers usually had access to a local market within a 20 kilometer radius or less at least once a week.

Table 49. Cost Per Gram of Protein of Selected Protein Foods[a]

FOOD	% Protein Content[b]	Kananga	Luiza	Dibaya
		(Zaires per Gram of Protein)		
Fresh Tilapia	12	.45	.29	.25
Salted Fish	59	.12	.19	.15
Sardines	24	.67	.87	.92
River Fish	19	N.A.	.34	N.A.
Beef, without bone	18	.89	N.A.	N.A.
Egg	10	2.40	.40	1.60
Milk, powdered	35	.64	.93	N.A.
Termites (nsua)	52	.20	.10	.10
Manioc Leaves	7	.08	N.A.	.11
Amaranth Leaves (ishiteku)	5	.30	.12	.26
Beans	23	.10	N.A.	.11
Rice, decorticated	8	.27	.16	.22
Maize, decorticated	9	.13	.03	.04
Manioc, dried and peeled	2	.85	.24	.28

[a]Market prices as of January 1984 for Dibaya and Kananga; as of November and December 1983 for Luiza. Based on measurements from a single purchase of each item in the market.

[b]Per 100 grams edible portion. Values from various sources: Balarin and Hatton (1979, p. 3); Oomen and Grubben (1978, p. 36), and U.S.D.A. (1981).

N.A. Not Available. This does not mean that the product is never present in that market, but rather that it was absent at the time when the price survey was conducted.

The importance of fish in the diet of consumers in all three research areas can be seen in Table 50. The frequency of consumption of fish purchased in the market is high, both among pond-operating and non-pond operating households. The majority of farmers in all categories bought fish at least once a week. However, a quarter of farmers currently raising fish in Kananga and Luiza reported only making fish purchases infrequently, as did 14% of those in Dibaya. These percentages were substantially higher than the comparative figures for non-pond operators in those areas.

Table 50. Frequency of Consumption of Fish From the Market

(153 Households Surveyed, 1983)

FREQUENCY	POND-OPERATING (I+S)			NON-POND OPERATING (D+N)		
	Luiza	Dibaya	Kananga	Luiza	Dibaya	Kananga
	(Percent of Households in Each Category)					
Infrequently	25	14	27	8	0	10
1 to 3 Times a MONTH	6	0	4	8	11	0
Once a WEEK	31	54	8	31	44	34
Twice a WEEK	12	9	14	23	11	17
3 Times a WEEK	12	18	20	23	11	17
4 Times a WEEK or more	13	4	28	8	22	22
	(Mean Number of Times)					
Month PRECEDING the Survey[a]	1.9	2.5	2.5	2.1	1.2	2.3[b]

[a]Means appear to be low given the frequency percentages reported above. This may be a side effect of the September devaluation which forced all families to adjust normal purchasing patterns.

[b]Mean value for 20 drop-out households only. This question was not asked non-participants in Kananga.

Although fish are in high demand, particularly among low income groups, tilapia producers must compete in a diverse fish market. River fish and eels from the vast array of Kasai rivers are sold fresh, dried, or smoked. Salted, dried and smoked fish are shipped from Shaba by train to local markets in both Kananga and Dibaya. Canned sardines and pilchards are imported from abroad. Urban fish farmers saw their market erode somewhat when shipments of frozen mackerel (mpiodi) were imported by air freight from the capital city, Kinshasa, beginning in April of 1983.[2]

The relative frequency of purchase of different types of fish by pond and non-pond operators is reported in Table 51. Consumers in Kananga and Dibaya relied most heavily on the salted fish (makaiyabo) and dried fretin coming from Shaba.[3] Both Luiza and Dibaya farmers had greater access to river fish and eels than did urban farmers, but households in Luiza reported consuming a higher percentage of both than did those in Dibaya.[4] A major contrast between pond-operating and non-pond operating households was that the former were far more

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[2]Mackerel were sold in 28 and 30 kg. cartons to local market women at Z26.67 per kilogram when they first became available in April of 1983. Following the devaluation in September, the wholesale price rose to Z40 per kilogram. By the end of November 1983, a total of 246,028 kilograms of mackerel had been flown into Kananga (Interfret, personal communication). It would take 61 hectares of ponds producing 40 kg/are/year to match that amount.

[3]Fretins were sold in small dishes or piles in the market. Respondents frequently remarked that they were the fish preferred by their children.

[4]It should be noted that consumption of snake-like creatures such as catfish and eels is prohibited among members of certain fundamentalist religious sects, such as the Apostles. A large community of Apostles lived in the research area in Dibaya which may have diminished both the supply and demand for these fish.

Table 51. Relative Frequency of Purchase of Different Types of Fish in Pond-Operating Households

A. Percent of I + S Households Surveyed

Kind of Fish	Luiza All of the time	Luiza Some of the time	Dibaya All of the time	Dibaya Some of the time	Kananga All of the time	Kananga Some of the time
Salted Fish (Makaiyabo)	31	56	86	4	60	36
Dried: Catfish	62	31	23	54	14	62
Mikebuka	12	0	18	54	31	54
Eels	44	50	23	64	12	48
Fretin	12	44	54	41	69	27
Canned: Pilchards	6	25	18	54	10	44
Sardines	6	31	23	50	15	42
Frozen Mackerel	N.A.	N.A.	N.A.	N.A.	75	19
Fresh: River	75	25	46	46	14	39
Tilapia from farmers	38	31	46	32	33	48
Tilapia from market	0	0	0	0	75	19

B. Percent of D + N Households Surveyed[a]

Kind of Fish	Luiza All of the time	Luiza Some of the time	Dibaya All of the time	Dibaya Some of the time	Kananga All of the time	Kananga Some of the time
Salted Fish (Makaiyabo)	23	62	89	11	63	32
Dried: Catfish	46	38	11	33	24	63
Mikebuka	17	17	33	44	22	61
Eels	38	54	33	67	10	51
Fretin	23	31	56	33	66	15
Canned: Pilchards	0	77	11	67	2	51
Sardines	8	85	33	56	10	51
Frozen Mackerel	N.A.	N.A.	N.A.	N.A.	78	17
Fresh: River	85	15	67	22	15	22
Tilapia from Farmers	17	85	11	78	12	46
Tilapia from market	0	15	0	0	78	17

N.A.: Not Available.

[a] 13 D+N households in Luiza; 9 in Dibaya; 41 in Kananga.
The percentage figures for households who never ate a particular kind of fish are not given, but are determined by summing the All and Some of Time categories and subtracting the subtotal from 100.

likely than the latter to purchase fresh tilapia regularly from neighboring fish producers.

The frequency of purchase often had little to do with the taste preferences of the farmer. Many remarked that the flavor of both canned sardines and pilchards was preferable to that of dried fish, but the former were too expensive. The high salt content of makaiyabo helped to account for its popularity, as rock salt purchased by the glass was rather expensive.[5] The consumption of frozen mackerel expanded rapidly as it developed a reputation as a meaty fish with few bones. Some individuals, however, stated that they had given up eating mackerel after having become ill. Given the poor quality of transport systems in Zaire, the frozen fish often were thawed and refrozen several times before being eaten.

Variations in frequency of purchase of the different kinds of fish were related to their comparative prices in each location. Transport costs considerably altered the value of a commodity between areas. For example, in January 1984, salted fish which sold for Z69 a kilogram in Kananga was Z88 in Dibaya. In Luiza, some 250 kilometers from the regional capital, the price of one kilogram of salted fish was Z111 in November of 1983. With the contemporary cost of a kilogram of fresh river fish in Luiza at approximately Z65, the economics of preference for the latter product is clear. In general, consumers that did not raise their own fish also benefitted from pond-produced tilapia because of it cost less per kilogram than river fish and was available year-round.

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[5]Most households purchased rock salt by the glass. As of January 1984, rock salt was Z19.4 per kilogram in Kananga compared to Z10 per kilogram in Dibaya.

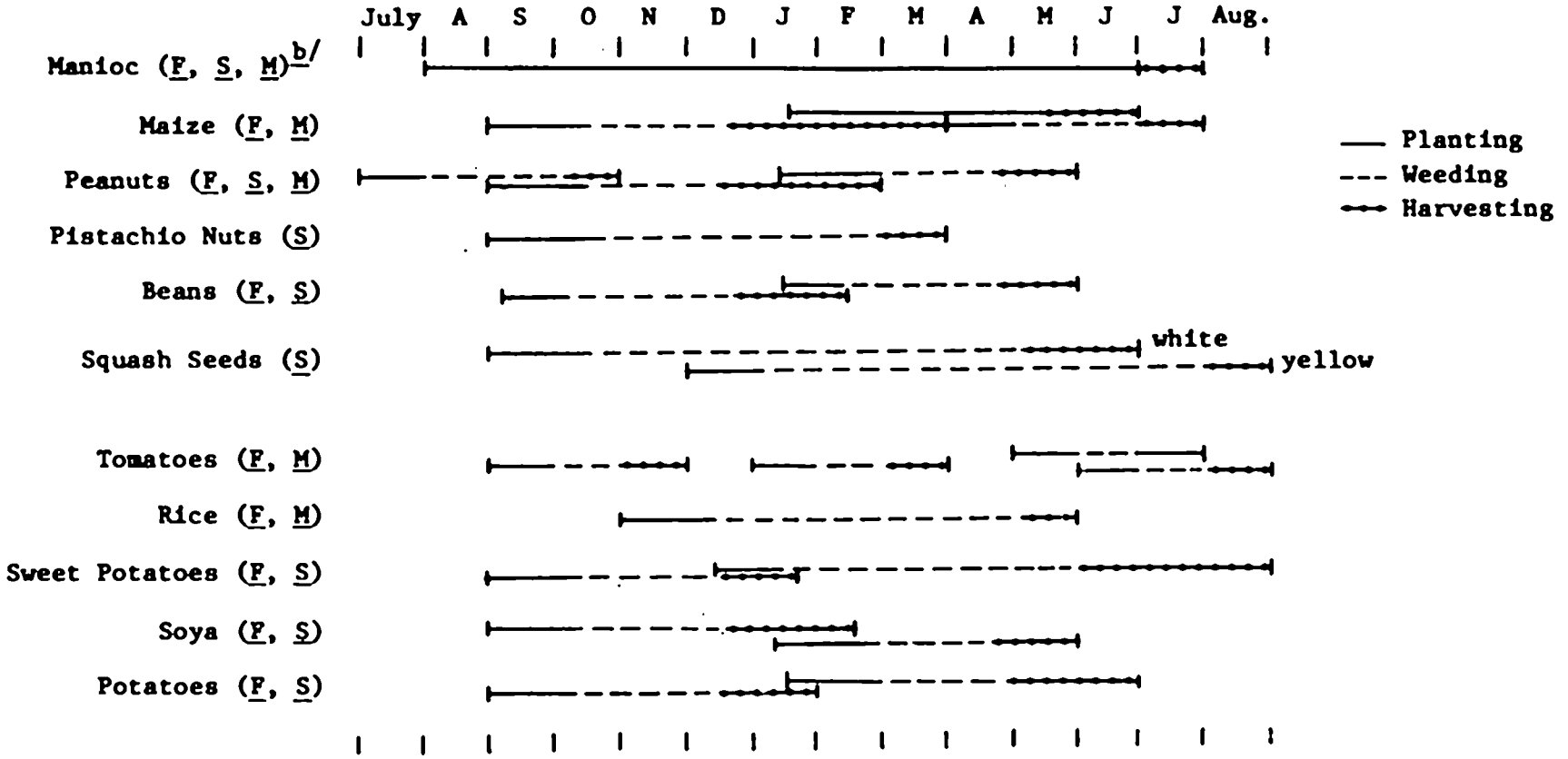
Factors Influencing Harvesting and Marketing Strategies

The complementary aspect of fish culture in relation to crop cultivation would be of greatest benefit at times when the need for cash that could be generated from pond sales coincided with a lull in agricultural work. High seasonal correlation between peak labor demands in the field and inadequate labor supply for intensive pond management might be expected if both men and women were significantly involved in both activities. Table 52 shows the percent participation by sex and age of pond-owning (I+S+D) households in crop production. Among households in the rural areas, the majority of adult men and women were involved in planting, weeding, and harvesting the principal crops grown. While women were principally responsible for crop marketing, 40% of the adult males in Luiza also took part (compared to 18% in Dibaya). A much smaller proportion of Kananga households had fields so the low percentages of participation in crop cultivation were expected. Moreover, the involvement of males less that 31 years of age in crop production in Kananga was much lower than that found for pondwork.

An agricultural calendar was constructed based on responses provided by farmers. This calender is shown in Figure 15. The busiest times affecting both male and female availability for pond culture occurred at planting time in September, weeding time in November, and during the months of December and January when the first season's crop would be harvested and land prepared for the second planting. Fewer labor bottlenecks were reported during the second planting season, except during the harvest times in May and June. The male labor supply for pondwork was further constrained

FIGURE 15. AGRICULTURAL CALENDAR FOR KASAI OCCIDENTAL[a/]

(F - forested areas; S - savanna; M - marsh)



a/ Periods for each activity represent the usual months during which such activities take place, not the exact number of days necessary to perform the operation. A month was added at each end of the calendar so seasons would not be broken.

b/ Manioc can be planted at almost any time of the year, except at the height of the dry season. It can also be harvested irregularly over a long period of time.

by having to clear forest land in mid-July and August. Total time devoted to clearing also depended on whether or not the farmer raised "swamp" crops in the valley floor during the dry season. If so, an additional clearing of land was usually necessary during the second growing season.

Table 52. Percent Participation by Sex and Age in Crop Production (116 Pond-Owning Households Surveyed, 1983)

	MALE		FEMALE	
Age Group:	6-15	>16	6-15	>16
ACTIVITY				
Clearing				
Luiza	0	68	15	40
Dibaya	4	74	9	27
Kananga	1	24	1	26
Planting				
Luiza	10	61	26	75
Dibaya	31	69	37	85
Kananga	5	24	3	34
Weeding				
Luiza	17	61	30	77
Dibaya	40	70	43	86
Kananga	10	26	9	36
Harvesting				
Luiza	14	61	26	75
Dibaya	38	64	40	86
Kananga	6	22	3	32
Marketing				
Luiza	7	47	15	60
Dibaya	2	18	14	61
Kananga	0	5	1	21
Processing				
Luiza	0	0	11	58
Dibaya	0	0	31	68
Kananga	0	0	0	16

The principal determinants for timing of harvest by the initial and secondary adopters surveyed (presented in Table 53) were divided into three categories: technical reasons which influence whether or not a person should harvest, a recurring need for cash at certain times of the year, and factors which might influence the ease of sale. The negative influence of one criteria might counterbalance the positive features of another. For example, ease of sale of fresh tilapia is enhanced when quantities of river fish and other kinds of meat in the market diminish. However, if this also corresponds to a period when potential buyers have little or no cash on hand, the selling of fish at the desired price will be difficult.

In general, the year-round demand for fresh fish was fairly high. When asked to name any months which were preferable for obtaining cash from a harvest, 22% of the Kananga initial adopters and 17% of those in Luiza expressed no preference, claiming all months were equally good. Even more significant is the fact that 45% of the Luiza initial adopters responded that there was no bad month for selling fish. Remaining farmers, especially those in Dibaya, cited a diverse set of reasons as to why certain times of the year were better than others for harvesting the ponds.

Harvesting decisions by Kananga fish farmers were less influenced by seasonal fluctuations in competitive protein alternatives than by the monthly fluctuation of income in households of salaried workers. The majority of initial adopters scheduled their harvests on or about payday for government employees.

Table 53. Criteria Cited As Important In Determining Harvest Times[a]

(As Reported by Initial & Secondary Adopters Surveyed)

FACTORS FAVORABLE TO HARVEST	FACTORS NOT FAVORABLE TO HARVEST
I. Technical Considerations	
Limited muck when the pond is emptied	Too much rain
Water available to refill pond	Insufficient water to refill pond
Restock in this month-- encounter high yield at next harvest (consistent warm temperatures)	Restock in this month-- encounter low yields at next harvest (cooler temperatures)
II. Need for Cash	
Need for money to pay school fees	
No other source of cash	
III. Ease of Sale	
Busy cultivating, no time to gather other food for home consumption	Recently harvested crops, do not need fish
No dried fish coming by train from Shaba (D,K)	Lots of meat and/or fish in the market
Not much river fish available	Lots of river fish available (D,L)
People have hunger at this time	Lots of termites available
	Burn fields for wild animals (L,D)
	People don't have enough cash to buy fish
Holiday Time: lots of buyers	Holiday time: people prefer other kinds of meat

[a]If the statement is not relevant for all of the research areas, those it does apply to are in parentheses: L=Luiza D=Dibaya K=Kananga.

Farmer responses were evaluated to determine preferable harvest times by ranking the prevalent responses to the aforementioned categories. If a category was favorable for harvesting in a given month, i.e. there was no significant labor conflict, a cited need for cash by the producer, or little or no constraint to the sale of fish for the expected, then the symboy (+) was assigned to that category for that month. A (-) was used to indicate the contrary

situation for each category, with an (*) representing the middle ground. Results are shown in Table 54.

There was a sharp distinction between the urban and rural sectors, mostly due to the greater need for cash and the reduced conflict for labor use in cultivation by those living in urban areas. More similarities existed between the two rural areas, the most desirable times for harvests falling in the dry season (late May through August) and December. In general, Dibaya farmers had lower cash resources and fewer inexpensive protein alternatives than did individuals in Luiza. Consequently, the ease of sale of fresh tilapia was somewhat greater in the former than in the latter. Labor conflict was more pronounced in Luiza during two months of the year as the men surveyed were more involved in trading than those from the Dibaya sample.

From the point of view of cash generation, the worst months for harvesting were February and March, which fortuitously coincided with a diminished need for cash in the rural sector. Though it was desirable to harvest in such months as September and November from the ease of sale and cash need standpoints, considerable labor conflict existed, and in the latter month, extensive rains made harvesting difficult.

The results of this section suggest one way in which the current extension strategy could be modified to enhance production and better meet the cash needs of farmers. This could be done by placing greater emphasis on managing the fish production cycle around periods where ease of sale is maximized at concurrent times of little conflicting labor use; the current strategy advocates adhering to a strict six month production cycle.

TABLE 54. RANKING OF CRITERIA FAVORABLE FOR HARVESTING BY MONTH AND BY AREA[a/]

Month		URBAN			LUIZA			DIBAYA		
	Ease of Harvesting[b/]	No Labor Conflict	Need for Cash	Ease of Sale	No Labor Conflict	Need for Cash	Ease of Sale	No Labor Conflict	Need for Cash	Ease of Sale
January	+	*	*	*	-	*	*	-	*	-
February	*	+	+	-	*	-	*	*	-	-
March	*	+	*	-	+	-	-	+	-	-
April	-	+	+	*	*	-	*	*	-	*
May	*	+	*	*	*	-	-	*	-	*
June	+	*	+	+	-	*	*	*	*	+
July	+	+	+	+	*	*	*	+	+	+
August	+	+	+	*	*	+	*	*	+	+
September	+	*	+	*	-	+	*	-	+	+
October	+	+	*	*	*	+	*	*	+	*
November	-	*	+	*	-	*	+	-	*	*
December	-	+	+	+	*	+	+	*	+	+
Annual Index Value		32	32	25	21	24	22	23	25	26

a/ See previous page for description of how criteria were evaluated. Annual index values were obtained by assigning a value of 3 to a (+), 2 to a (*) and 1 to a (-). Index values, therefore, could range from a low of 12 to a high of 36.

b/ No heavy rains.

Drying Tilapia as a Possible Marketing Strategy

Farmers raising smaller quantities of tilapia (<15 kgs.) encountered few problems in the marketing of their fish. The question arises whether those farmers capable of producing larger quantities of tilapia (>35 kgs. per harvest) would be better able to deal with the vagaries of the marketplace if they were to dry their fish, and thus, not be as subject to price variations resulting from inelastic supply.

The economics of drying tilapia for the urban market were analyzed by gutting and smoking approximately 10 kilograms of fresh tilapia at the regional fish station in Kananga and determining the price at which the smoked tilapia would have to sell so that at least the equivalent fresh tilapia price would be obtained. This would indicate whether the values for both small and large smoked tilapia at cost would be price competitive with other dried fish on the market.

Representative samples of the various kinds of fish available in Kananga were purchased and weighed in November of 1983. The comparative values of these are presented in Table 55. The higher price per kilogram found among dried as opposed to fresh fish was expected as the latter have lost more than 50% of their original weight in the drying process. More surprising, however, was the lower cost of the imported salted makaiyabo than the locally produced tilapia (Z62 per kilogram vs. Z69). The high price of dried eels and catfish compared to fretins, mikebuka, and mayanga helps explain why they are not as frequently consumed as the latter.

Table 55. Comparative Value of Different Kinds of Fish in the Kananga Market, November 1983

KIND OF FISH	COST: ZAIRES PER KILOGRAM
Salted fish (*makaiyabo*)	61.9
Dried: Catfish (*tubobo*)	359.3
Eels (*tushi*)	390.6
Mikebuka	184.7
Fretins	166.8
Mayanga	107.2
Canned sardines[a]	160.7
Frozen mackerel (*mpiodi*)	98.1
Fresh tilapia	68.8

[a]Sardines were packed in oil. The fish were removed from the can and all excess oil drained off before weighing. Canned pilchards were also available--a 450 gram can cost Z25. However, the individual fish were not weighed separately from the sauce and therefore, the cost for kilogram figure was not included for pilchards in this table.

Details of the drying trial, and the results are reported in Table 56. Smaller fish (<14 cms. in length) lost a greater percentage of their weight (72%) than did the larger fish (60%) and required more labor input to clean. Although it took a longer amount of time to smoke the larger fish, fewer technical problems were encountered than with the small fish. The latter were more likely to burn or fall through the rack made of local palm rachises. When the variable labor cost was included, large tilapia would have to sell for at least Z108 a kilogram, making them price competitive with other dried fish on the market. The smaller fish would be competitive with all dried fish, except for the mayanga. Needless to say, salted fish would still remain a cheaper alternative.

Table 56. Value of Smoking Fresh Tilapia in Kananga, November 1983.[a]

Condition of Fish	Weight of Sample (kgs.)	No. Fish per kg.	% Change in weight	PRICE PER KILOGRAM without labor cost[b]	with labor cost[c]
Large Fish[d]				(Zaires)	(Zaires)
Whole	5.00	15.0		40.0	--
Gutted[e]	4.50	16.6	-10	44.4	44.8
Smoked	2.00	38.0	-60	100.0	108.2
Small Fish					
Whole	4.47	62.0		35.0	--
Gutted	4.24	62.0	- 5	36.8	37.7
Dried	1.25	221.0	-72	125.0	130.6

[a]Based on a smoking trial conducted using Oreochromis niloticus at Katuishi fish station in November 1983.

[b]The price for large tilapia was that used at the station in November 1983. The price for small tilapia set by the fish station (Z25) was far below the going average price demanded by project farmers (Z35). The latter was used to estimate the price at which smoked tilapia would have to sell in order to earn the equivalent of the fresh fish.

[c]Labor costs were calculated using wages paid to station labor as a base. Workers received Z15 per 7 hour work day. Inputs were measured for smoking 9.47 kgs. of tilapia: 14.0 person-hours to collect wood (8 one meter long pieces plus .5 cubic meter of smaller sticks); cleaning of the large and small fish took 1.0 and 1.8 person-hours, respectively. Smoking all the small fish required only 3.25 hours compared to 11.67 hours to completely dry the larger fish. Fixed labor costs for constructing the 2 X 1.1 X 1.3 mud-walled, thatched roofed hut for smoking were not included.

[d]Large and small fish were separated by length (not weight) for expediency. All tilapia greater than or equal to 14 cm in length were classified as large.

[e]Fish were gutted, but not scaled.

The evidence suggests that for farmers with large harvests it might be profitable to dry tilapia that are at least 30 grams in weight. However, it should be noted that fresh tilapia approximately 75 grams or more usually sell much faster than smaller fish, and make up a smaller proportion of the total harvest. It would be beneficial, therefore, to explore new approaches to smoking smaller tilapia that would overcome the problems mentioned above.

VII. MANAGING POND OPERATIONS

The ready acceptance of the idea of raising one's own fish among farmers in Zaire usually leads to a rapid spread of awareness and interest among residents in a given area. The initial adoption of pond culture is facilitated by the fact that this activity can be undertaken on a scale consistent with the farmer's physical capacity and willingness to risk becoming involved in a new endeavor. In most instances, the first pond built will be 1 to 2 ares in size, and the level of management required is not complex as all feed resources are focused in one place. A bountiful harvest subsequently touches off a desire to expand the operation, and frequently inspires more hesitant neighbors to become involved. This upsurge in interest is often to the benefit of the initial adopter who then becomes a major source of fingerlings for stocking new ponds.

The decision to expand the size of an enterprise, even if it goes beyond the farmer's ability to feed intensively, is consistent with a risk minimization strategy. In principle, an individual possessing a six to seven pond operation with a year-round water supply would be harvesting once a month, thereby having a regular source of income and/or additional food. With several ponds in production, the odds are higher that any given pond could provide a substantial amount of cash if it had to be harvested in case of a family emergency. Likewise, in areas where theft is a problem, a farmer with few ponds may feel vulnerable to being completely wiped out.

Table 57. Eight Initial Adopter Pond Operations in Kananga: Size, Number of Harvests, Average Yields, and Kilograms Produced

(Data from 171 harvests, 1979 through 1983)

Principal Feed:	BREWERY WASTE					LEAVES & TERMITES		
Farmer Number:	1	2	3	4	5	6	7	8
				(19 __)				
Year Production Began	81	81	79	80	80	79	79	81
PONDS in Production:				(Total Number)				
1st year	2	2	1	1	2	1	2	2
2nd year	4	3	3	8	3	6	3	5
3rd year	5	4	4	8	9	10	5	6
4th year	-	-	4	-	9	10	5	-
ARES in Production:				(Total Number)				
1st year	3.4	3.6	2.5	6.5	4.2	0.8	3.3	3.0
2nd year	7.5	5.6	9.3	18.6	7.1	3.6	5.4	6.3
3rd year	9.4	7.7	19.5	18.6	18.6	7.0	12.1	8.6
4th year	-	-	19.5	-	18.6	7.0	12.1	-
AVERAGE YIELD:				(kgs/are/year)				
1st year	33.1	33.4	11.3	34.5	35.6	43.8	25.1	13.4
2nd year	41.9	56.1	27.8	23.0	24.1	30.6	15.5	11.3
3rd year	39.2	35.1	24.6	38.0	17.8	16.8	14.6	10.1
4th year	-	-	17.1	-	28.3	19.4	11.9	-
KILOGRAMS PRODUCED:				(Total Number)				
1st year	54.5	65.0	26.0	135.0	81.5	17.5	39.0	20.5
2nd year	234.6	162.0	92.0	339.7	116.0	85.0	74.0	63.5
3rd year	228.6[a]	120.0[a]	210.5	683.0	277.0	82.9	143.2	29.0[a]
4th year	-	-	185.5	-	150.0[a]	104.0	47.0	-
ESTIMATED VALUE:[b]				(Nominal Zaires)				
1st year	2095	2030	845	4050	2445	438	975	656
2nd year	8167	5464	2760	10529	3648	2415	2220	2440
3rd year	9144[a]	4800[a]	6468	25276	10056	2621	4582	1160[a]
4th year	-	-	7208	-	6000[a]	4104	1880	-

[a]These figures are lower than the preceding year because an entire year of production had not been completed at the time of the survey.

[b]Estimated by multiplying the kilograms produced times the following prices per kg.: Z25 for 1980, Z30 for 1981, Z32 for 1982, Z40 for 1983.

One of the principal goals of the extension program is to teach farmers how to enhance yields from their pond operations through the use of intensive management techniques. Yield from a given pond is determined by how well the ponds are fed and the length of the production period. The ability of a farmer to manage his/her ponds is inextricably tied to the quality and availability of feed resources in the area.

The chapter focuses on how the expansion of the pond operation affects tilapia production. The analysis is based on information gathered from eight households in the Kananga area who kept pond records consistently since stocking their first ponds. These eight initial adopter households were considered to be "successful" because the farmers had continuously operated their ponds (except for absences due to illness) and the receipts obtained outweighed the costs incurred for each year the ponds functioned.

Five of the eight households relied primarily on brewery waste as a feed, while the remaining three depended upon leaves and termites. Both occasionally made use of other types of feed as well. All of the households composted on a regular basis, but the availability of animal manures to mix with leaves and grasses was limited. The most important aspects of these operations are summarized in Table 57. The 171 harvests recorded by these farmers provide a factual base for comparing yields within and between households, and for relating yield differences to such factors as the resource base, the average size of ponds, and the scale of operations.[1]

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[1]An estimate for the weight equivalent of those fingerlings sold by farmers prior to harvest time was added to the recorded production figures.

Yield as a Function of the Resource Base and Size of the Operation

There are two ways in which a farmer can augment output from a pond system: through expanding the size of the operation or by intensified feeding of the existing ponds.[2] When the total surface area is increased, there is a concurrent incremental growth in "natural" production, which is approximately 5 kgs. per are per year. The contribution of natural production to total output can also be enhanced by lengthening the production period beyond six months. Any surplus production generated would be the number of kilograms harvested which exceed that which could be attributed to natural production alone. Yield calculations are based on the surface area of the pond and are inclusive of the contribution made by natural and surplus production.[3]

The 8 Kananga households included in the intensive survey had been raising fish for periods ranging from 2.5 to more than 4 years at the time of the survey. The date of the stocking of the farmers'

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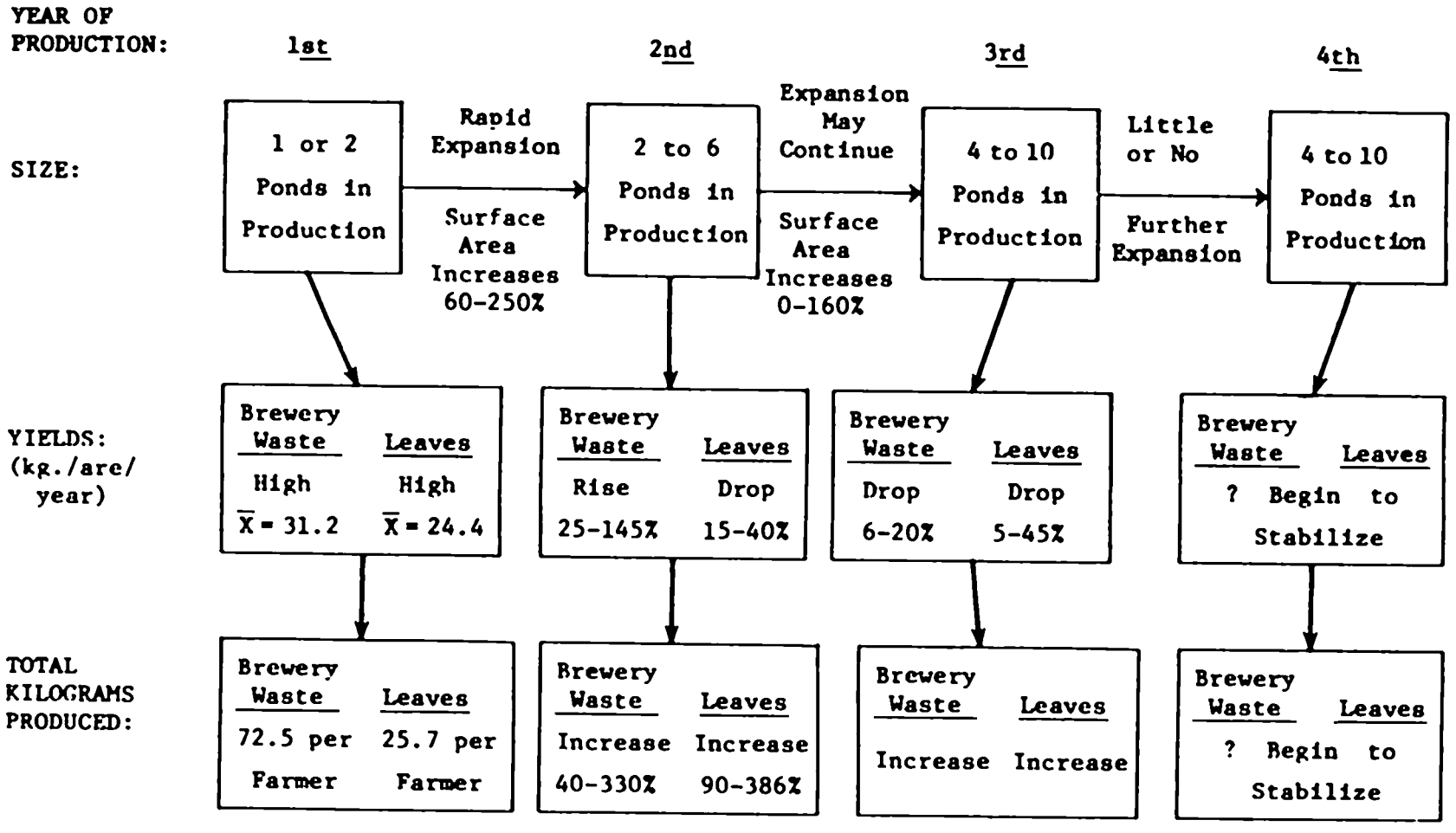
[2]Changing the stocking rate of fingerlings can also have a considerable effect, particularly if the pond was previously understocked. Ideally, fingerlings should be stocked on a per weight basis to ensure accurate determinations of net production values. However, a much simpler method of stocking 1 to 2 fingerlings per square meter was used by the extension service. In virtually every instance, project farmers used these minimum stocking rates. Certain individuals preferred to overstock, but higher than recommended densities could not augment net production unless feeding was also greatly intensified. Stunting of adult fish was the more likely consequence of overstocking. Since stocking rates were usually maintained at adequate levels, adopting alternative rates was not considered as a possible strategy for augmenting total production.

[3]It should be noted that depth is an important criterion in determining total production. Increasing depth usually results in higher yields. Because of the difficulty in accurately measuring the depth of a filled pond, surface area is almost always employed.

first pond was designated as the commencement of the first year of production. Farmers continued to expand the size of their operations, particularly during the initial three years of production. Values in Table 57 show that none of the 4 households who had completed their fourth year in production had augmented the number of ares in tilapia production during that final year. Two of the farmers had encountered space limitations in their valleys; one was still in the process of constructing a six are pond; and the remaining farmer had begun to consolidate the smaller ponds he owned into larger ones.

When a composite picture for these households is drawn (see Figure 16) there is a distinct contrast in the influence of scale on brewery waste and leaf feeding households. As would be expected, average yields in the initial year of production were higher for households utilizing brewery waste (31.2 kgs. per are per year) than for those feeding leaves and termites (24.4 kgs. per are per year). Yields in subsequent years varied considerably--ranging from a high of 70.2 to a low of 1.5 kgs. per are per year. Compared to the first year of production, average yields rose or fell in brewery waste feeding households depending on whether sufficient feed was obtained to keep pace with the growth of the operation. In 3 of the 5 households, average yields rose from 25 to 145% in the second year of production. Yields fell by 32% in the two remaining households feeding brewery waste, and by 15 to 45% in those feeding leaves. During the third year of production, mean yields dropped

FIGURE 16. GENERALIZED PORTRAIT OF THE EXPANSION OF URBAN POND OPERATIONS



6 to 20% in brewery waste households and from 5 to 45% in leaf feeding ones.[4]

Thus, as farmers expand their operations, feed becomes more limiting. In addition, labor resources are stretched too thin. Even those farmers who maintained consistently good yields (Number One and Two) opted to continue to expand the size of their operation knowing that they would encounter difficulties obtaining enough feed to manage all of the new ponds intensively. This strategy is pursued because the total kilograms produced continued to rise despite a drop in yields. For instance, the annual production in leaf feeding households increased from 90 to 386%, even when average production per are declined. Moreover, the contribution of natural production as a percent of the total quantity of fish harvested increased in significance for leaf feeders as the number of ares in production expanded. Figure 17 demonstrates the increasing importance of natural production in leaf feeding systems as the farmer increased the size of the operation during the first and second years of production. Clearly, individuals with access to brewery waste were able to capitalize on the expansion of the system by intensifying feed inputs at the same time.

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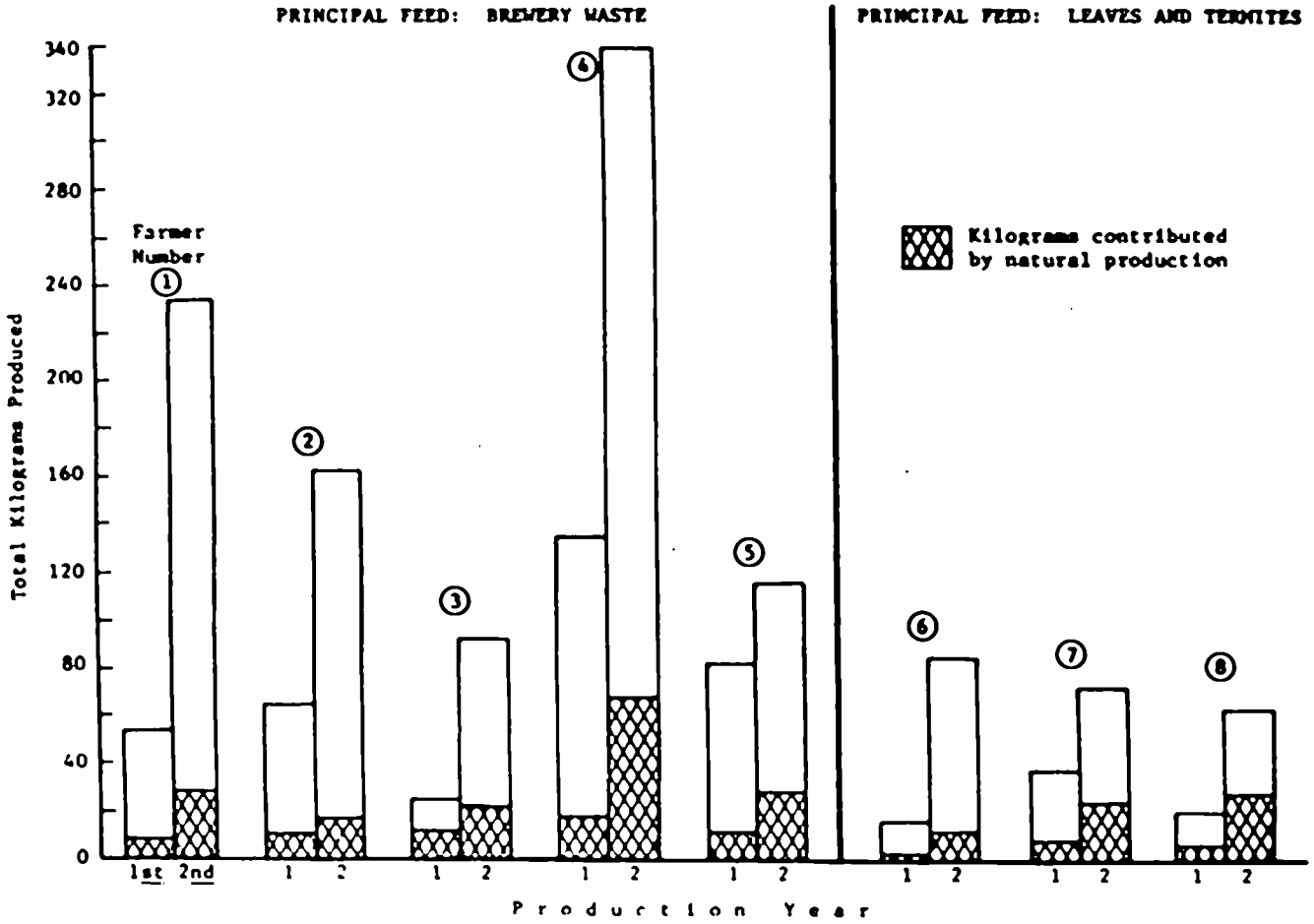
[4]The only exception to this pattern was Farmer Number Four. In this household, the mean yield decreased during the second year, and increased the third. This pattern was the opposite of what was seen in the other 4 brewery waste households and is probably due to the farmer having purchased several authentic ponds that were put into production fairly rapidly during the first and second years of operation. The other farmers expanded their operations through the construction of ponds on undeveloped sites.

FIGURE 17. THE IMPORTANCE OF NATURAL PRODUCTION IN DETERMINING TOTAL KILOGRAMS PRODUCED IN FIRST AND SECOND PRODUCTION PERIODS

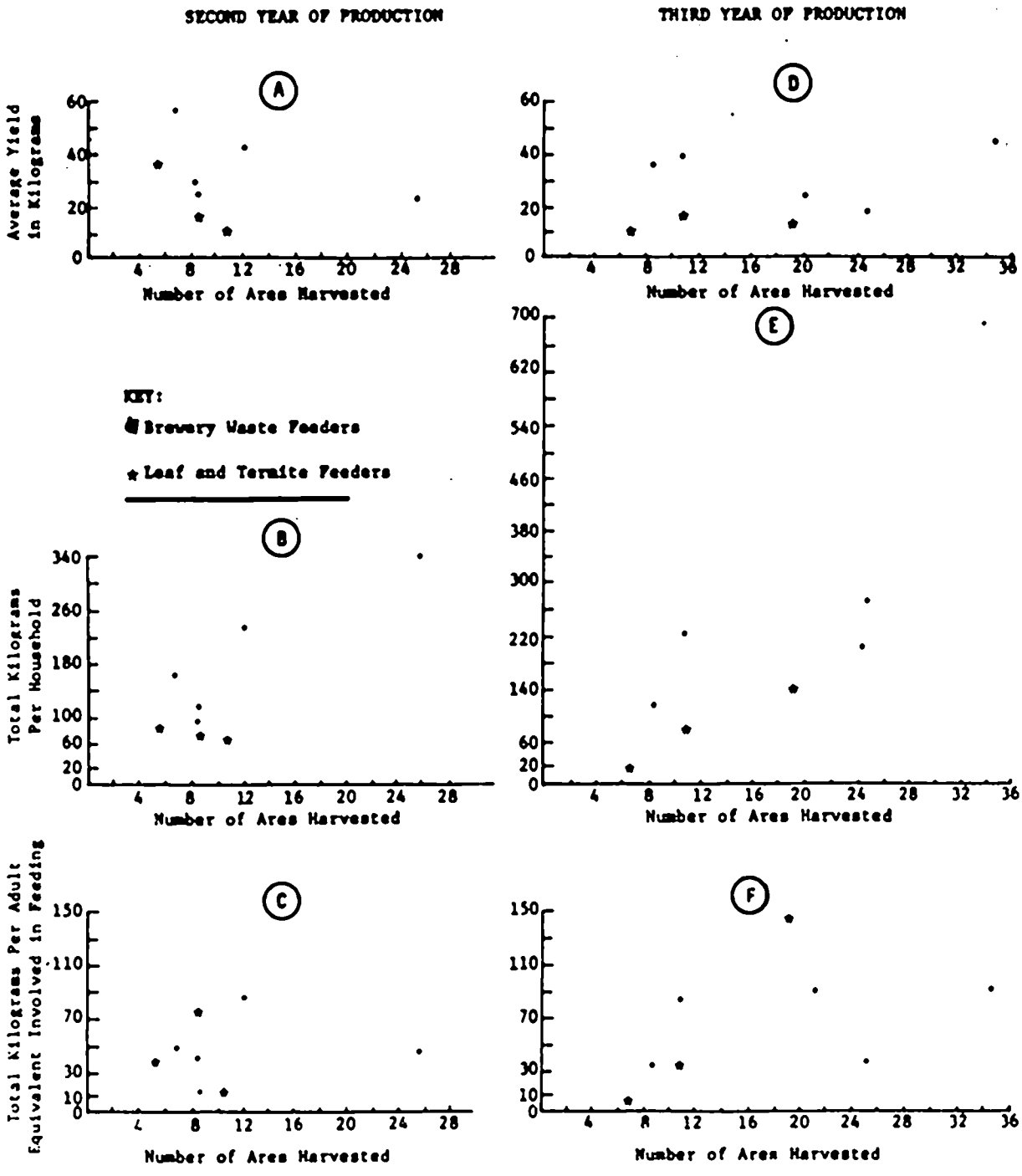


As the building of additional ponds ceases, or at least slows, one would hypothesize that output over time would begin to stabilize. Although the sample size is too small to draw any generalizable conclusions, several points of interest emerge when mean yield and output per household are plotted against the total number of ares harvested in a given year (see Figure 18). Much greater expansion occurred during the second year of production than in the third. In the second year, there was some indication that average yields declined as the total number of ares harvested by the different households increased (see Figure 18A). Although yields declined in leaf feeding households as well, total output did not vary greatly whether 5.5 or 10.8 ares were harvested (see Figure 18B). However, among brewery waste feeding households, there was a sharp concurrent rise in total production during the second year with the increase in ares harvested.

The situation reversed by the end of the third year of production. Average yields no longer varied consistently with the total number of ares harvested (see Figure 18D). The highest values obtained in both types of households in the second year were not reached in the third, but the overall decrease in yield appears to be unrelated to the number of ares harvested per household. Total output, however, tended to expand as the number of ares harvested rose in both leaf and brewery waste feeding households (see Figure 18E).

The augmentation of total output in both years also was due in large part to the availability of additional household members to assist in feeding the fish. When total kilograms produced was

FIGURE 18. YIELD AND OUTPUT AS A FUNCTION OF ARES HARVESTED



divided by the number of adult equivalent household members[5] who participated in feeding, the range of values for total output as a function of area harvested narrowed considerably (see Figures 18C and 18F). Principal fish farmers in the large brewery waste operations relied heavily on supplemental family labor to aid with feeding, whereas other farmers were constrained by lack of sufficient labor supply as well as by limited feed resources. In this respect, Farmer Number Seven, a leaf feeder, can be regarded as a much better pond manager than might be concluded based on mean yield or output per household figures. This is because all of the 143 kilograms produced in the third year of production were strictly due to his individual feeding effort.

Yield in Relation to Individual Pond Size

Successful pond operators apparently seek to maximize total production of tilapia rather than output per unit of land. Thus, the question arises as to what is the optimal pond size for a farmer with limited feed resources who may or may not be facing labor constraints. Two factors must be considered in determining the optimum pond size. First one needs to examine the relationship between pond size and yield. Second one needs to consider marketing problems that may be associated with larger ponds. If the surplus production obtained is in excess of what the local market can easily

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[5]All persons older than 15 years were considered to be adults. A child's contribution to feeding was valued as a .33 adult equivalent. The number of adult equivalent household members participating in feeding ranged from 1.0 to 7.3 in these 8 households.

absorb, the farmer will have to accept a lower return for his or her effort. In such cases, having several smaller ponds instead of one or two large ones may make it easier to market the output. Conversely, if the production from a small pond can barely meet the immediate needs of the family, little surplus will be available for sale.

Yield and output per household were plotted against individual pond size for harvests that occurred in the second and third years of production.[6] No ponds larger than 5 ares in size were found in the leaf feeding households. While brewery waste feeding households attained better yields than leaf feeders in all pond size categories, there was no significant bias towards higher or lower yields as pond size changed. The output per household from larger ponds was also highly variable (see Figure 19). Most brewery waste feeders were able to exploit larger total surface areas much more effectively than leaf feeders.

Comparing values in parts A and B of Figure 19, it appears that a farmer with brewery waste available could produce 25 kilograms of tilapia in a one-half to one are pond, whereas the leaf feeder would most likely need at least a two are pond to raise the same quantity of fish. Thus, if the farmer's goal is to have surplus production to sell in addition to food for the family, minimum pond

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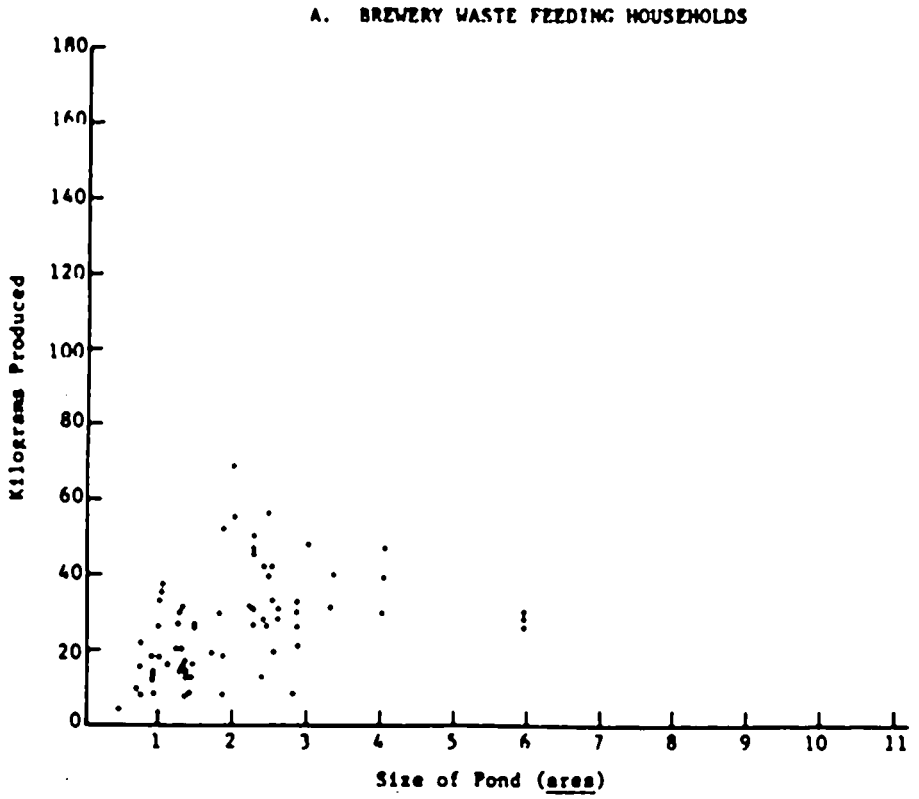
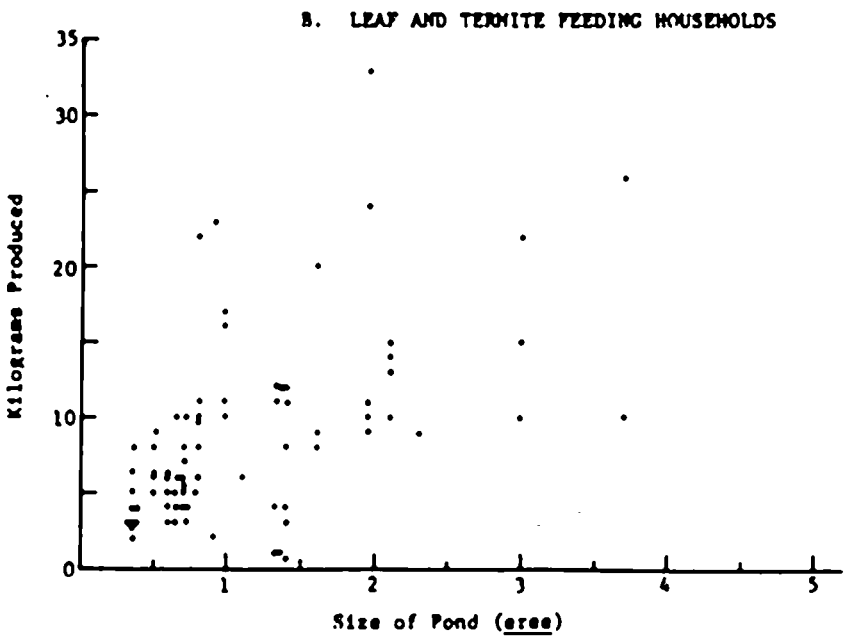
[6]First year production figures were not included as these yields were higher than average production values that could be sustained by a pond operator in the long run.

FIGURE 19. OUTPUT IN RELATION TO INDIVIDUAL POND SIZE PER SIX-MONTH PERIOD





size for those without access to brewery waste and significant quantities of animal manure should be raised to 2.0 ares.[7]

In practice, the dimensions of a new pond are determined mainly by the physical features of the site. For example, valley floors that are gently sloped permit the construction of larger ponds than do steeply sloped floors. Often, beginning farmers are anxious to obtain fish as fast as possible and so construct small ponds that barely meet the minimum size currently advocated by the extension service (1.0 are), if even that. However, any leaf and termite feeder who would like to produce surplus production for sale would be wise not only to exploit the land area available to him/her, but to build ponds that are large enough to have a significant contribution from natural production. Though limited in scope, the evidence presented here suggests that for most farmers optimal pond size would be from 2 to 5 ares. Farmers with access to agricultural by-products as feeds should build individual ponds towards the upper end of the scale, especially if they are near an urban market. Yields from the first year of production are not indicative of what can be maintained as the farmer expands the operation. Mean values from the third year of production can be considered as more representative of what initial adopters can sustain in the long run.

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[7]Experience has shown that a farmer harvesting 25 kilograms in one day is usually able to meet immediate family needs and have some surplus left for sale.

Net Present Worth of Rural Versus Urban Pond Operations

The costs and benefits of establishing and managing a 6 are pond system were hypothesized to compare the effects of differing labor resources on fish culture profitability in the urban and rural sectors. The scenarios were based on relative prices as of January 1984, values for subsequent years are expressed in constant 1984 Zaires. Each household is assumed to have constructed 2 ares of ponds during 3 consecutive years with the rural operator developing a forested site with clay soils and the urban operator exploiting a sandier site with few trees. Present values were calculated using a real discount rate of 12%.[8]

In the rural area, the financial cost of labor as determined by the salary earned by a state agricultural worker was assumed to be representative of the social opportunity cost of that labor (Z14.2/day).[9] Based on the weekly expenditures of crop cultivating households near Kananga, the social opportunity cost of agricultural labor for the urban area was assumed to be twice the foregoing rate (Z28.4/day). Assumptions regarding labor input, derived from medium

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[8]In countries with a high inflation rate, it is particularly difficult to determine what the real rate of interest is. In an extreme case like Zaire, the real rate is probably low, or even negative. Twelve percent, however, is a real rate commonly used for project analysis in developing countries (Gittinger, p. 314). The nominal discount rate for Zaire would be much higher than 12%. One plausible value for the nominal rate is given by annual interest rates on Treasury bonds issued in April 1983: 40% for bonds held for 28 days, 42% for 56 days, and 45% for 91 days (Q.E.R. (1984), p. 10).

[9]As of January 1984, the lowest level of salaried government labor was for agricultural workers: Z368 per month divided by 26 working days equaled Z14.2 per day.

range values estimated on a per are basis in Chapter V, are described in Tables 58 and 59.

Comparative values of a 6 are system in two rural sites with equivalent construction costs, but differing amounts of family labor available for feeding and composting the ponds are shown in Table 58.[10] Both households were assumed to have access to leaves, termites, and limited quantities of animal manures, and to have been able to attain good yields of 40 kilograms per are per year in their first year of operation. It is reasonable to assume that there are few economies of scale in feeding and composting ponds when leaves and termites are the principal feeds. Thus, in case A, a household desiring to maintain the high yields of the first year would have to multiply the time involved in gathering the necessary quantity of feed accordingly. In this instance, the labor requirement increased from 45 to 270 person-days per year as the pond system expanded from 1 to 6 ares. The net present value of the 15-year operation would be Z33,540, with payback on the investment occurring by the end of the first two years of operation.

Based on information presented in this section, case B is a much more realistic assessment of what is likely to happen in a rural setting. The household has a limited quantity of labor to devote to feeding and composting activities. As the size of

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[10]No constraint on the amount of supplemental labor available for construction was assumed because of survey results showing that farmers usually employed neighbors or relatives in building the ponds. Much of this labor force (young men, in particular) would disperse once building was completed and would not be incorporated into the labor pool involved in feeding and composting.

Table 58. Net Present Worth of a Hypothetical Rural Six Are Operation[a]

A. Maintaining High Yields: No Labor Constraints

	Cost (in Zaires)					Value (in Zaires)			
YEAR	Canal & Pond System	Operating Labor[c]	Finger-lings	Shovel	TOTAL COST	Yield (kg/are/year)	TOTAL REVENUE	Net Benefit	NET PRESENT WORTH at 12%
1	2130	639	40	130	2939	40	1800	-1139	-1017
2	1988	1917	-	-	3905	40	5400	1495	1192
3	1988	3195	-	130	5313	40	9000	3687	2625
4	-	3834	-	-	3834	40	10800	6966	4430
5-15	-	42174	-	-	42174	40	118800	76626	26290
								TOTAL:	33520

B. Labor Constraint For Feeding and Composting Activities

	Cost (in Zaires)					Value (in Zaires)			
YEAR	Canal & Pond System	Operating Labor	Finger-lings	Shovel	TOTAL COST	Yield (kg/are/year)	TOTAL REVENUE	Net Benefit	NET PRESENT WORTH at 12%
1	2130	639	40	130	2939	40	1800	-1139	-1017
2	1988	1420	-	-	3400	29	3915	507	404
3	1988	1420	-	130	3538	18	4050	512	365
4	-	1708	-	-	1708	18	4860	3152	2005
5-15	-	18788	-	-	18788	18	53460	34672	11895
								TOTAL:	13652

[a]All values in constant January 1984 Zaires (Z30.12=$1). One kilogram of tilapia valued at Z45. Price of labor equal to Z14.2 per day (salary of state agricultural worker).

[b]Forested area with clay soils: 2 ares constructed in each of 3 consecutive years. Assumed 150 person-days used in initial year; 140 person-days in years 2 and 3.

[c]In evaluating costs for composting, feeding, maintaining, and harvesting the ponds, no economies of scale were assumed. The pond was harvested only once in the year it was constructed; twice in all subsequent years. For pond operators maintaining high yields, 45 person-days of operating labor were assumed; 135 for the second year; 270 in subsequent years. For pond operators with a limited quantity of labor available, the following assumptions were made: 45 person-days of labor in the initial year; labor input was restricted to 100 person-days in years 2 and 3; An additional increment of 20 person-days became available for managing the system in subsequent years once construction had been completed.

the operation expands, yields fall but total production rises, and hence, total revenue increases. In the second and third years of operation, a maximum 100 person-days of labor would be available to devote to managing the ponds. In subsequent years, an additional 20 person-days of labor was included as a limited amount of the family labor involved in pond construction became available. Net present value was still positive, but much lower than for the high yield scenario, and an additional year was required to realize the payback on the investment.

In the urban area, having a regular supply of brewery waste available as feed makes a significant impact on the positive net worth of the operation. This is due to the low cost of feed per kilogram of fish produced combined with the reduction of time spent in feeding activities. Both leaf and brewery waste feeding households faced lower labor input demands for constructing pond systems in the non-forested urban setting (see Table 59). Lower total costs plus higher yields resulted in the net present value of the brewery waste feeding operation being 1.5 times that of the rural household maintaining good yields.

The sensitivity of the net present value of operations to the price attributed to labor is evident in the urban leaf and termite feeding household. Even though the labor input involved in construction was only one-third that required in the rural area, the higher cost of daily labor meant that the net present value for this system was only Z5147, less than half that found for the rural system facing similar labor constraints.

Table 59. Net Present Worth of A Hypothetical Urban Six Are Pond Operation[a]

A. Brewery Waste Feeding Household

	Cost (in Zaires)						Value (in Zaires)			
YEAR	Canal & Pond System[b]	Operating Labor[c]	Finger-lings	Shovel	Purchased Feed	TOTAL COST	Yield (kg/are /year)	TOTAL REVENUE	Net Benefit	NET PRESENT WORTH AT 12%
1	1420	398	40	130	162	2150	45	2025	-125	-112
2	1278	1193	-	-	720	3191	50	6750	3559	2837
3	1278	1988	-	130	1080	4476	50	11250	6774	4823
4	-	2386	-	-	1080	3466	50	13500	10034	6382
5-15	-	26246	-	-	11880	38126	50	148500	110374	37868
									TOTAL:	51798

B. Leaf and Termite Feeding Household With a Labor Constraint

	Cost (in Zaires)						Value (in Zaires)			
YEAR	Canal & Pond System	Operating Labor	Finger-lings	Shovel	Purchased Feed	TOTAL COST	Yield (kg/are /year)	TOTAL REVENUE	Net Benefit	NET PRESENT WORTH AT 12%
1	1420	1278	40	130	-	2868	40	1800	-1068	-954
2	1278	2840	-	-	-	4188	29	3915	-203	-162
3	1278	2840	-	130	-	4248	18	4050	-198	-141
4	-	3408	-	-	-	3408	18	4860	1452	923
5-15	-	37488	-	-	-	37988	18	53460	15972	5481
									TOTAL:	5147

[a]All values in constant January 1984 Zaires (Z30.12=$1). One kilogram of tilapia valued at Z45. Price of labor was assumed to be Z28.4 per day.

[b]Sandy area with a few trees: 2 ares constructed in each of 3 consecutive years. Assumed 50 person-days used in initial year; 45 person-days in years 2 and 3.

[c]No economies of scale were assumed. For brewery waste feeding households 14 person-days of operating labor were assumed per are of production: a total of 14 person-days required in the first year, 42 the second, 70 the third, and 84 in all subsequent years. For the urban leaf and termite feeding household, the same assumptions regarding operating labor as those made for the rural household with a labor constraint were made.

Several points of interest emerge from this analysis. First, it would be advantageous to either rural or urban households to have credit facilities available so that the construction of the entire system could be completed as rapidly as possible. Benefits would then accrue at an earlier stage. The ability to hire additional labor for feeding and composting so that higher yields could be maintained would be advantageous as well. In the urban sector, the availability of credit might permit poorer farmers to purchase brewery waste in bulk, although the principal problem in this case is limited supply not inadequate cash resources. However, as it now stands, credit facilities are virtually non-existent, and even if they did exist, interest rates would be exorbitant given the high opportunity cost of capital.

One of the most economical ways for farmers to expand the size of their systems would be to purchase partially cleared sites or abandoned ponds adjacent to their existing operations. The low cost per square meter values for valley land in Kananga has been mentioned previously, and such purchases are already occurring. In the rural sector, however, pond sites are more spread out and less frequently abandoned. The return to labor for urban pond operations not having access to farinaceous by-products is limited. On the other hand, future development of pond systems near rural centers with milling facilities could prove to be highly profitable. In the long run, however, the most viable system sustainable on a widespread basis in Zaire will remain the small-scale rural operation utilizing "excess" family labor when available to produce supplemental income and food for home consumption.

VIII. SUMMARY AND RECOMMENDATIONS

The purpose of this study was to assess the socioeconomic impact of the adoption of fish pond culture on family well-being in Kasai Occidental, Zaire. The three research areas chosen (Luiza, Dibaya, Kananga) had all been previously exposed to tilapia culture during colonial times, and were the initial sites selected in this region by Projet Pisciculture Familiale for the introduction of intensified feeding techniques using a new species, Oreochromis niloticus.

An extension program staffed by Peace Corps volunteers was initiated in the rural Zone of Luiza in 1977, and expanded into the rural Zone of Dibaya and the urban center of Kananga in 1979. An assessment of the project's overall effect was made by conducting interviews between October 1983 and February 1984 in each of the original locations where the extension service had operated for at least four years. At the time the survey was made, most of the original project participants in the first Luiza site had not received any extension visits for two years, while the majority of project farmers in Dibaya and Kananga had worked with an extension agent in 1983. In total, 153 farmers were interviewed, of which 46 were initial "model" adopters still raising fish; 44 were secondary adopters, of which 54% had never had any contact with the extension service; 26 were individuals who had abandoned their ponds; and 37 were non-participants. This information was supplemented by direct observations of pond-related activities, surveys of market prices, and statistics from government sources and local businesses.

The extension program focused on locating and training a core group of model individuals who would be visited on a weekly or bimonthly basis. Direct contact between extension agents and rural farmers was viewed as the best way to transmit information to farmers having at best some primary school education. Though many farmers had previously been exposed to the idea of pond culture during colonial times, the concepts of proper canal and dike construction, feeding the fish twice daily, and composting on a regular basis using animal manures and other vegetal material were new to the vast majority of participants.

As pond culture adoption progressed, distinctive differences in the costs and benefits of the enterprise to households in the different areas became apparent. The principal issues which influenced the success of tilapia pond culture in a given zone were: 1) site selection, 2) choice of participants, 3) pond construction, 4) feeding and composting, and 5) marketing strategies. The lessons drawn from this study relevant to each of these issues are summarized below.

A. Site Selection

All three areas possessed the four most essential features necessary for fish culture to be adopted within a two-year period, namely: a high level of interest among the population, a sufficient number of valleys having year-round water supplies, local markets available for selling fish; and adequate population densities to make the use of farmer-operated ponds as demonstration models feasible. The slightly acidic water (pH ranging from 5.5 to 6.0) characteristic of the study

areas was below the neutral to slightly basic conditions favored for tilapia cultivation, but was not highly detrimental to production.

In addition, one area (Luiza) had several natural endowments which enhanced the ability of farmers to achieve higher yields, e.g. clay soils, animal manure available in a large percentage of the households, and a small opportunity cost for using manioc leaves as feed. However, pond culture survived and expanded in another rural area (Dibaya) despite less favorable conditions. Average yields obtained under those circumstances were lower, but the benefits derived from home consumption and supplemental income were significant, especially when compared to the contribution from other cropping activities.

Marketing conditions were best in the densely-populated urban sector, where demand for fresh fish was high year-round. Urban producers faced less seasonal competition from river fish than did rural growers and relied more heavily on tilapia sales as a means of generating income for purchasing basic foodstuffs. The presence of a limited supply of agricultural by-products (especially brewery waste and maize mill sweepings) permitted higher yields to be attained at lower cost by those producers with access to them. However, the high visibility of urban pond systems resulted in a greater incidence of theft from the ponds, more conflicts over land rights, and greater interference from local authorities than that encountered in the rural sector.

B. Choice of Participants

The original participants tended to be more established members of the community in their early forties to fifties. The selection of older individuals was frequently a conscious choice on the part of the extension service. Nonetheless, it was also a reflection of greater preference among younger men, in particular, for diamond digging and other non-agricultural endeavors.

Certain advantages and disadvantages are inherent in this emphasis on older model farmers. The likelihood of success in engaging in a new endeavor is higher for motivated individuals already respected for their proven abilities as cultivators. Bountiful first harvests are often crucial for establishing project creditability in a new area. Moreover, these initial adopters had a larger pool of family labor to draw on for constructing and managing the pond system as well as greater financial resources for hiring additional assistance.

In the introductory phase, it is desirable to work with farmers who want to build larger pond systems to guarantee an adequate supply of fingerlings in the area as interest in tilapia culture expands. Since the role of adult women and older children in pondwork is considerable, younger unwed male adopters often do not have the labor resources necessary to construct the larger operations characteristic of initial adopters. Production levels attained in secondary adopter households are also adversely influenced by the limited labor pool available for gathering feed. This helps explain why the majority of rural secondary adopters who abandoned their ponds cited insufficient time or labor as the principal reason for doing so.

Male secondary adopters were often unsuccessful in the urban setting. Most had no fields to rely on for feed supplies and limited cash resources for purchasing by-products. Interest was keen among youth in their teens and twenties, and they rapidly adopted pond culture. However, the combination of low levels of production, excessive theft, and the legalization of diamond digging in 1983 led to the abandonment of most urban ponds owned by younger males.

The major drawback to concentrating on older individuals as model operators is their age. Because the average life expentancy of a Zairian is only 47 years (World Bank (1982), p. 110), the project cannot expect the principal fish farmers from initial adopter households to be managing their operations for more than 10 to 15 years. The likelihood is high, however, that the ponds constructed by initial adopters will not be completely abandoned when the farmer dies. Moreover, emphasis can be switched to training a large reservoir of secondary adopters once the program has been established in an area.

Equal in importance to total labor supply is the productivity and consistent availability of that workforce. Absence form the pond operation by the principal fish farmer due to illness or trade-related travel was found to be considerable in several of the initial adopter households. This would have an adverse effect on the regularity of the feeding and supervision the system more so than on the completion of such activities as clearing and construction.

C. Pond Construction

The fixed costs of land and tools necessary for pond construction are insignificant compared to the variable costs incurred in managing the ponds. Land in the rural sector usually could be acquired free of charge; previously exploited sites in Kananga could be purchased at a low price per meter squared. Items such as machetes and hoes that were used in crop production also were available for pond construction. Shovels, however, were sold on an irregular basis in the rural areas and, if available, were rather expensive to purchase. A substantial proportion of shovels found both in the rural and urban households were either broken or in extremely poor condition. Tools were frequently borrowed from family or friends when constructing a pond. Functioning wheebarrows were virtually non-existent in all households.

The amount of time devoted to clearing and constructing a one are pond was highly variable. Recall data provided figures ranging from 15 to 90 person-days per are, the lower figure corresponding to a sandy area with few palm trees and a nearby water source; the higher to forested valleys where clay soils predominated.

All households relied mainly on family labor for pond construction and maintenance. Most initial adopters also hired neighbors and relatives to assist in building the ponds. Payment in the rural areas was principally by providing food and drink. Although cash remittance dominated in the urban sector, approximately a quarter of the pond operators in Kananga did all the construction on their own.

From the data gathered in this study it appears that there was no critical shortage of labor for clearing and constructing ponds.

Relatively few farmers considered insufficient labor to be the most significant problem they encountered in constructing their ponds. However, the physical intensity of site clearing and pond contruction restricts participation in the forested valleys to healthier individuals.

Optimum pond size could not be conclusively determined based on data from 171 harvests recorded by 8 Kananga households. In part, this is because yield figures are determined on the basis of surface area alone rather than the total volume. While brewery waste feeding farmers attained better yields than leaf and termite feeders in all pond size categories, there was no significant bias towards higher or lower yields as pond size changed. The output per household from large ponds was highly variable. However, the evidence suggests that leaf and termite feeding households desiring to have some surplus production for sale should build ponds at least 2 ares in size. Ponds 2 to 5 ares in size appeared to be preferable when both production and marketing considerations were taken into account. Farmers with access to agricultural by-products as feeds should build ponds near the upper end of the size scale, especially if they are near an urban market. Ultimately, the choice made within the given physical limitations of a site is between having numerous, small ponds (consistent with a risk minimization strategy) or fewer, larger ones (simplifying management problems).

D. Feeding and Composting

Adequate composting and feeding are the key to attaining higher levels of production. In the rural sector, the labor time involved in gathering compost and feed materials was the most significant cost element. Farmers in Kananga who were able to exploit inexpensive brewery waste or mill sweepings as a feed substantially reduced their production costs.

Obtaining adequate amounts of feed is not a problem when an initial farmer in a given area has only a few small ponds. But as success attracts more operators, and the total number of ponds in the immediate vicinity increase, feed resources in an urban area become more limiting and labor resources in a rural area may be stretched too thin for the ponds to be intensively managed.

A low level of feed supply forces operators to adopt an extensive management strategy. This means that natural production as a percent of the total quantity of fish harvested increases in significance as the number of ares in production expands.

In general, successful pond operators sought to maximize total production of tilapia rather than output per unit of land. Thus, mean yield values from the third year of production were more representative than those from the first year of what initial adopters can sustain in the long run.

The majority of both initial and secondary adopters fed at least once a day. Composting, however, was a more difficult practice to have Kasaian farmers perform on a regular basis because of their lack of familiarity with the technique in general, plus difficulties involved

in obtaining and transporting animal manures. Farmers wanting to employ organic manures had to be willing to tether or confine the animal for a portion of the day or night in order to facilitate manure collection.

The major drawback to using organic wastes for fertilization are the substantial quantities required for them to be effective. Most farmers with more than a few ares in production did not have enough animals to meet their composting needs. Furthermore, supply does not guarantee use. For example, many farmers in Luiza owned animals but did not compost on a regular basis.

The responsibility for supplementary feeding was often dispersed among various household members. Males of all ages were significant participants in supplementary feeding in rural initial adopter households. The same held true in Kananga, except for males 16 to 30 years of age. The contribution of both children and adult women in supplementary feeding was much greater than in composting. Given the importance of feeding in enhancing production, it follows that a larger proportion of extension time and seminar training sessions should be redirected to include adult women.

In the rural areas, cash is rarely used to purchase fish food. Manioc and papaya leaves, termites, and manioc waste are commonly used. In the city, the competitive value of manioc leaves as a human food made its use as a feed uneconomical. Use of by-product feeds, when available, is generally profitable. The major constraint is the limited supply of the least expensive feed, which is brewery waste.

Although the situation regarding by-product supply is not likely

to improve markedly in the immediate future, a possible solution to the lack of composting material in the urban area now exists. Under a F.A.O. pilot project undertaken in 1981 sacks of inorganic fertilizer were sold on an individual basis, beginning in 1983. Though the cost of one sack is high (Z180 for 50 kilograms as of December 1984), the economic value is clear. A farmer applying 1.1 kgs/are every two weeks would only have to produce one extra kilogram of fish in order to cover the cost of the fertilizer. Production is likely to be augmented four to six times that amount due to the increased nutrient supply. As is the case with brewery waste, the farmers can obtain inorganic fertilizers without having to depend on the fish project. P.P.F. does not have the facilities nor staff available to be able to sell and distribute fertilizers in the rural sector.[1]

E. Marketing Strategies

The demand for fresh tilapia is relatively high year-round because of its lower price per kilogram when compared to other meats and animal by-products such as milk and eggs. Maximum benefits from the sale of tilapia occur to the household at times when the cash needs of the family coincide with a high demand for fresh tilapia. As they gained experience operating ponds, farmers tended to extend or shorten production periods so that harvesting occurred at more desirable times.

In rural areas, the greatest need for cash for farmers in the survey fell around the months of July, August, September, October,

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[1]PROPA was selling inorganic fertilizer on an affordable per kilogram basis in the Kalunga Mesu are of Dibaya at a subsidized price (transport costs from Kananga were not included).

and at holiday time in December. In June and July, involvement in pond activities was highly complementary with a lull in agricultural work. By late July and August, however, male labor supply became constrained by having to clear forest land for cultivation. Both male and female availability for pond culture declined significantly during crop planting time in September, weeding time in November, and during the months of December and January when the first season's crop would be harvested and land prepared for the second planting.

Urban farmers faced consistently high cash needs year-round, and hence scheduled harvests at times when salaried workers received their paycheck in order to minimize sales made on credit.

If year-round market price, household expenditure, and labor input data had been available for all three areas, one could construct a model to determine the optimal harvest strategy. While farmers could recall times when ease of sale was highest or lowest, predicting price trends was more difficult. Because the data needed were not available, recall information was used to rank criteria favorable for harvesting by month and by area.

In most cases, the harvesting and marketing of a pond of tilapia took place in one day. There is approximately equal participation by men and women in the harvesting process.

Fish marketing is typically viewed as a woman's activity, but adult men in Luiza and Kananga also were heavily involved in the marketing process. The greater involvement of men in marketing in rural Luiza may be due partly to their reported authority within the household regarding decisions on cash expenditures. Several households in Dibaya

and Kananga, on the other hand, indicated that the guarding and spending of household funds was either under the female head of the household's jurisdiction, or jointly decided.

Tilapia producers had to compete with many other kinds of fish. The greatest competition faced by urban fish farmers is from the less expensive salted fish or, more recently, the higher-priced, but meatier frozen mackerel. In rural areas, producers face competition from fresh river fish on a seasonal basis, and occasionally dried fish as well. The cost of smoking fresh tilapia for the urban market was examined and found to be economically feasible, but probably advisable only for those farmers producing large quantities of fish on a regular basis (e.g., >35 kilograms per harvest).

F. The Value of Tilapia Production

The benefits of engaging in pond culture were assessed from two standpoints: the production of fish for home consumption and the sale of tilapia as a means of generating income. Tilapia production made a significant contribution to income in more than half of the households surveyed. It was among the top 3 income-earning activities in 63% of the pond-operating households in Luiza, 50% of those in Dibaya, and 64% of those in Kananga. The importance of pond culture as a means of generating income was most significant in the urban sector where cash was needed to purchase basic food staples. In rural areas, the ability to obtain cash during times of the year when other sources of income were not available was often as important to fish farmers as the actual amount earned.

The income gained from selling tilapia complemented but did not surpass that from crop sales in most rural households. Only 31% of the initial adopters in Dibaya and Luiza reported that they made more money from their ponds than they did from sales of their top 3 cash-earning crops in 1983. In contrast, all Kananga initial adopters who sold some produce from their fields found fish cultivation to be more profitable. Most secondary adopters, both rural and urban, stated that their crops earned them more money than selling tilapia.

In an absolute sense, total production and income generated annually from the sale of fish was greater in the relatively prosperous rural Zone of Luiza than in the poorer rural Zone of Dibaya. Fish farmers on the average in Luiza built more and larger ponds than did their Dibaya counterparts. However, the relative contribution of pond culture may be greater for Dibaya households because fewer income earning opportunities exist and crop production provides lower returns than for Luiza families. Both initial and secondary adopters in Luiza made approximately 3.5 times more from the sale of their most important crops than did those farmers in Dibaya. This raises the question as to whether, in the rural sector, the extension effort should concentrate in areas of greatest need, not necessarily those which are preferable from a purely technical standpoint.

Much of the benefit from pond culture was derived from having a year-round supply of protein for home consumption. A high proportion of tilapia harvested was reserved for family use, and a substantial amount of fishing from the ponds occurred between harvest times. Sixty-three to 73% of initial and secondary adopter households in

the research areas reported that they did some fishing on a regular basis. As a result, yield figures based on harvest weights alone can understate actual production levels attained. Estimates of production lost due to fishing were made on the basis of farmer responses.

The preference for home consumption over market sale is likely to increase if the purchasing power of the Zaire continues to decline, particularly in the urban area. In Kananga, the rise in the price of tilapia often lagged behind that of more basic foodstuffs. Twenty-five kilograms of fish that purchased 4.5 sacks of manioc in October of 1981 could buy only 1.25 sacks in December of 1983. To counter this trend new marketing strategies might be adopted, such as smoking fish or selling smaller quantities at a time.

G. Implications and Recommendations

The use of direct agent contact on a regular basis is one of the most expensive forms of information transmission,[2] but should logically be judged against the much higher cost of establishing and maintaining equivalent government fingerling centers in an area. The initial emphasis on the training of model farmers for other adopters to emulate appeared to be crucial for establishing confidence in the viability of fish culture in a new location. Few initial adopters abandoned their ponds, even in areas where extension contact had been

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[2]For example, a comparative study of the cost of different extension techniques used in Malawi reported the following figures for cost per unit "contact" hour (in 1980 dollars): $.004 by radio; $.168 using a mobile unit with films; $.083 using a mobile unit with puppets; $10-30 using an extension agent (Media in Education and Development, 1982).

minimal or non-existent for the year or two preceding the survey. The concurrent failure of a fish extension program operating in the same part of Dibaya Zone but following a different strategy confirms the necessity of stressing the "quality" as opposed to the "quantity" approach in the beginning phases of an extension effort. In this case, the PROPA development agency desired to help as many people as quickly as possible and adhered to the policy of distributing fish to any farmer who had water available, regardless of whether a pond of adequate size and strength had been constructed. Not one of the hundreds of "PROPA-stocked" ponds was observed functioning three years later, farmers having abandoned operations after dikes broke during heavy rainstorms, or because they were discouraged by low yields. The relevant questions regarding participant selection by P.P.F., therefore, should center more around proper directions for the extension program in an area once model systems have been established.

Tilapia production is a labor intensive operation that provides a high gross return per unit of land in both the urban and rural areas. Once established, the return to labor from a rural pond operation appears to be comparable to or surpass that gained from maize or peanuts. Since families in the rural sector obtain significant benefits from pond culture even if the ponds are only extensively managed, bringing in more participants has merit even if it means working less intensively with the initial adopters.

When working with secondary adopters, emphasis should be placed on site selection and pond construction--the foundation of the entire operation. For those households headed by younger men in their twenties

and thirties, the principal goal should be to achieve a level of "enhanced subsistence", i.e. knowing how to restock and manage at least 2 ponds. Although teaching management techniques to secondary adopters should not be ignored, greater reliance could be placed on less costly secondary materials and group seminars. Younger farmers often have received more schooling than those over 40 years of age, permitting more extensive use of written educational materials. Direct extension contact with regard to management skill should be concentrated on the initial adopters because high yields demonstrated at harvest times are the most effective means of conveying the importance of consistent feeding and composting to other farmers.

Secondary adopters in Kananga face two serious constraints that make the widespread sustainability of their operations doubtful in the long run. First, the incidence of pilfering is higher in urban than in rural areas. This means that pond operators must own a sufficiently large number of ponds to justify the supervisory time necessary to prevent excessive theft. In addition, small operators must rely on purchasing by-products to feed their fish as most do not have fields. The majority buy feed in smaller quantities at a higher price per unit that do the more established larger adopters. Thus, both the costs and risks are higher for secondary adopters in urban than in rural areas.

Extension efforts in Kananga should concentrate on "model" farmers, because they are the only ones capable of sustaining their operations in the long run. Furthermore, they perform a useful service in providing large amounts of fish for the urban market. In the urban environment,

the "poorest of the poor" benefit more by having low-cost fresh fish available in the market (or from stealing from their neighbors) than by engaging in pond culture themselves. The poorest urban dwellers lack adequate supplies of feed and labor and are particularly vulnerable to pilfering.

Partial Harvesting As A Possible Management Strategy

The major production bottlenecks to increasing tilapia production in the research areas included in this study centered around the lack of sufficient feed and composting materials for intensively managing the preferred scale of operation either due to insufficient labor supply and/or lack of processed by-products. Larger operations are more difficult to manage as decisions regarding quantities to be fed to each pond and when to harvest must be made more frequently. This is especially true for farmers lacking sufficient literacy to keep adequate pond records. Therefore, any new strategies that would simplify operating the whole system, or would reduce labor time, while maintaining or increasing production should be regarded as possible improvements of a basically sound extension strategy. One approach to improving the profitability of fish culture among initial adopters is to alter the recommended harvesting strategy, i.e. shift from complete to partial harvesting.

Partial harvesting entails the netting of fish for sale or consumption without having to completely drain the pond. Under this strategy, complete drainage of the pond would not be entirely abandoned for it is essential to dry out the pond bottom occasionally to prevent

disease problems and excessive stunting through overstocking. Instead of completely harvesting the pond every six months, draining would occur 11.5 months after the initial stocking, thereby setting aside 2 weeks for refurbishing the pond. One partial harvest would replace the first 6-month harvest.

There are several biological, managerial, and marketing advantages to adopting a schedule of one partial and one complete harvest annually. These are summarized below:

Biological Advantages:

1) The nutrient base established during the first 6 months of composting could be retained for an additional production period, thus reducing the labor cost inherent in establishing a plancton bloom.

2) The determination of when to partial harvest could take into account the adverse effect of colder temperatures ($<22^{o}C$) on tilapia growth and reproduction rates. When initial stockings are made from January through March, the subsequent production period includes a significant number of colder dry season days. Therefore, longer production periods before partial harvesting took place (6.5 to 7 months) could be chosen. During the warmer rainy season, shorter lengths of production periods (5.5 to 6 months) could be selected by farmers able to maintain feed supplies.

Managerial Advantages:

1) Pond management would be simplified as the farmer could schedule harvesting and draining each pond at a particular time each year, e.g. pond X could always be drained in February, and pond Y in October.

2) Complete drainage of the pond would be avoided in those months where refilling of the pond would be difficult owing to insufficient rainfall, e.g. during June, July, and August.

3) Complete drainage could also be avoided during periods of heavy rainfall to avoid substantial damage to the cut dikes. In addition, it is difficult to dry out pond bottoms completely during the wettest months of the year (November, March, April).

Marketing Advantages:

1) The scheduling of both partial and complete harvests could be organized around times of seasonal requirements for additional food or cash.

2) Partial harvesting provides a more flexible means of minimizing the price effects of excess supplies of tilapia appearing at times when large quantities of competing sources of protein are available. Partial harvesting could be carried out over several days if necessary. This is less expensive than harvesting a large volume and smoking or drying the surplus.

An optimal partial and complete harvesting schedule based on the above criteria is shown in Table 60. The major drawback of this approach is that the adoption of partial harvesting would most likely entail the use of imported netting. As mentioned previously, the fine-meshed seine netting ideal for trapping fingerlings is not now manufactured in Zaire. Large-meshed gillnets, on the other hand, are occasionally sold in Kananga. Lovshin and Pretto-Malca (p. 503) reported that they were able to harvest tilapia in Panama employing 2-,3-, and 4-inch stretch mesh gillnets. The use of gillnets was preferred because they were locally available, cheaper, and easier to handle than an equivalent length of seine net. In addition, tilapias can readily pass under a seine net in deeper water. However, locally-manufactured gillnets in Zaire are much less durable than seine nets, requiring frequent repair. They are also inappropriate for capturing fingerlings for stocking ponds as they tend to inflict greater physical damage than do seine nets. If only one type of netting were to be stocked and sold by the project, the seine net would be preferable in that it can perform both functions and would last longer.

Table 60. Proposed Harvesting Strategy for Kasai Occidental

Initial Stocking (Time of Month)	Partial Harvesting (Length in Months)	(Time of Month)	Complete Harvesting (Time of Month)
Beginning of JANUARY	6.5	mid-July	mid-December
	7.0	beg. of August	
Mid-JANUARY	6.5	beg. of August	beginning of January
	7.0	mid-August	
Beginning of FEBRUARY	6.5	mid-August	mid-January
	7.0	beg. of September	
Mid-FEBRUARY	6.5	beg. of September	beginning of February
	7.0	mid-September	
Beginning of MARCH	6.5	mid-September	mid-February
	7.0	beg. of October	
Mid-MARCH	6.5	beg. of October	beginning of March
	7.0	mid-October	
Beginning of SEPTEMBER	5.5	mid-February	mid-August
	6.0	beg. of March	
	6.5	mid-March	
	7.0	beg. of April	
Mid-SEPTEMBER	5.5	beg. of March	beginning of September
	6.0	mid-March	
	6.5	beg. of April	
	7.0	mid-April	
Beginning of OCTOBER	5.5	mid-March	mid-September
	6.0	beg. of April	
	6.5	mid-April	
	7.0	beg. of May	
mid-OCTOBER	5.5	beg. of April	beginning of October
	6.0	mid-April	
	6.5	beg. of May	
	7.0	mid-May	
Beginning of NOVEMBER	5.5	mid-April	mid-October
	6.0	beg. of May	
	6.5	mid-May	
	7.0	beg. of June	

Although hardier than gillnets, seine nets are more difficult to repair, and farmers would have to be admonished to refrain from using the nets for river fishing owning to to the harsh conditions encountered. Regardless of which type of netting was chosen, more time would have to be spent instructing farmers on proper maintenance and repair techniques than has necessary in the past.

The sale and distribution of whatever netting was chosen would have to be done judiciously, as meeting the demand of the entire community would be extremely costly. When a program is first being established, the extension agent is better able to insure quality pond construction if he/she controls the availability of the fingerling supply in the area. Once several initial adopters begin harvesting, nets could be used as an incentive to encourage better management techniques. For instance, a farmer who had obtained high average yields (given the available resource base) for three or more harvests would be able to purchase a net. Hopefully, by this stage the farmer would have grasped the concepts of tilapia culture well enough so that the net would not be used to overfish the pond in-between harvest times.

Engaging in the sale of nets creates an unwanted "dependency" on the project. For this reason, it would be desirable to persuade local manufacturers to make finer-meshed netting.[3] Alternatively, the project could encourage the development of rental schemes whereby an individual would hire a net-owning farmer to help him/her harvest.

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[3]Several local businessmen in Kananga remarked that small-meshed netting was not produced in Zaire because the government wanted to discourage the removal of fingerlings from the rivers, but the validity of this statement was not verified by the author.

In the past, the extension service has been fairly successful in establishing guidelines for base prices for fingerlings sold by project farmers to new participants. It is likely that farmers would be receptive to the rental scheme idea if a fair value for their services could be established. Moreover, this undesirable aspect of net distribution is not as serious as the problems that would be encountered in distributing other inputs such as inorganic fertilizers.

Overall, the positive attributes of adopting a partial harvesting strategy in terms of enhancing total output and self-sufficiency of the operation outweigh the negative features. It should be stressed, however, that this approach can only be recommended for areas like Kasai Occidental where schistosomiasis (bilharzia) is not endemic in local waters. For this reason, it would not be an appropriate strategy in either Kasai Oriental or Bas Zaire.

Monitoring and Evaluation

In assessing the effectiveness of projects that introduce new technologies and/or management techniques, emphasis is typically placed on the level of output achieved. The system of monitoring the progress of P.P.F. has been conducted in this vein. Quarterly reports submitted by extension agents focus on the easily quantifiable dimensions of the program: total surface area, average yields, total kilograms produced, etc. While these numbers are valuable, they often fail to reflect the dynamic nature of an extension program. Once pond culture has been established in an area, it is physically impossible for an extension agent to be present at every single harvest as his/her

efforts are divided between developing new pond operations in addition to advising already established fish farmers. However, these numbers do reflect current workloads and the general growth of interest in an area. Greater emphasis on record-keeping by the households themselves, and the creation of a standardized permanent record book for each extension agent, would vastly improve the accuracy of the system.

Extension agents should continue to give priority to technical problems, not bookkeeping tasks. Two modifications for the current report form are proposed that would make it possible to obtain a more accurate assessment of the project's impact while not unduly increasing the administrative burden on the extension agents.

Because the principal goal of the project is to enhance family subsistence levels, emphasis should be placed not only on recording the number of farmers being contacted, but on the number of farmers that have achieved a certain level of "enhanced subsistence". Minimal standards could be set by the project staff. For instance, an enhanced subsistence farmer could be defined as one who has: 1) at least 2 well-constructed ponds that can be drained; 2) a minimum of 3 ares in production; 3) harvested and restocked his/her ponds at least once under the supervision of an extension agent; and 4) received written material on pond culture and/or attended a farmer seminar. Realistic yield averages could be derived for each area, and total annual production estimates included in year-end project assessments.

In addition, the pond operations of a limited number of initial adopters, not to exceed 5 or 6, could be more intensively monitored

by an extension agent. Given that there were over 50 extension agents working in Zaire as of January 1984, detailed information on different model systems could be collected and compared. Identifying factors which influence the profitability of pond culture in each area would help agents to adopt a strategy to best meet the needs of farmers operating under different climatic and economic conditions.

Moreover, although the possibilities for organizing viable animal-fish systems appear limited, the prospects for integrating fish culture extension with crop improvement efforts are brighter. The importance of manioc leaves both for human consumption and as a fish food has already been mentioned. The destruction caused by mosaic virus and other diseases attacking the manioc plant is evident throughout the region. P.P.F. could assist the national manioc improvement program (PRONAM) by distributing improved varieties to fish farmers. Likewise, given the increasing importance of gardening as an income generating activity in Dibaya, the possibility of further integration of pond-vegetable systems could be explored. It would be beneficial to attempt to coordinate new and on-going extension activities in the Dibaya area with PROPA, as it provides a potential source of long-term continuity for the program.

I. Conclusion

The results of this study emphasized the distinctive differences between pond systems developed in two rural areas (Luiza and Dibaya) versus those in an urban area (Kananga) of one particular region. One must recognize that the economic situation in Kasai Occidental differs to some degree from that existing in other regions in which the fish project operates (Bandundu, Bas-Zaire, Kasai Oriental). The dominating influence on any agricultural or pond endeavor in the two Kasais is the "diamond factor." The existence of diamond digging as an alternative means for generating income places a high opportunity cost on all other activities, particularly for young men. A diamond economy enhances the mobility of women as well as men as high prices in the urban market encourage greater participation in trading than might otherwise be the case if the diamond sector did not exist. The difficulty of undertaking any new activity is accentuated further by the deteriorating physical and economic infrastructure found throughout the country. However, the technical feasibility of establishing small-scale pond operations in Zaire is high, as raising tilapia is one of the simplest forms of animal husbandry that can be successfully adopted on a widespread basis by low-income farmers. All tilapia exhibit a high degree of disease resistance and *Oreochromis niloticus* can exploit a wide range of food resources, including plankton, leaves, and farinaceous by-products.

In its first five years of existence in Kasai Occidental, Projet Pisciculture Familiale not only survived but expanded and prospered during a time of increasing economic chaos. The success of the project

in reaching farmers was due mainly to its small size which minimized administrative problems as well as corruption. The cost of maintaining a direct contact extension service is high because the project concentrates on reaching the ignored rural agricultural sector, a sector plagued a lack of sufficient infrastructure and technical inputs, such as shovels. A large number of farmers learned the basic techniques of tilapia culture and benfited mainly by having fish available for home consumption and an emergency source of cash. Farmers with access to sufficient amounts of feed and labor were able to generate considerable surplus production from their tilapia ponds on a regular basis. The ability of the majority of farmers to do likewise is limited by the availability of these resources. Thus, improvement in crop production is essential for increased fish production on a regional scale. Most of the individuals now engaged in fish farming possess the management skills necessary to produce additional surplus for sale if they could obtain additional feed.

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APPENDIX A

INITIAL SURVEY: FARMERS CURRENTLY OPERATING PONDS

Name: _____ ____ Had contact with an extension agent

Date: _____ ____ Built ponds alone

Zone: _____ Interviewer: _____

Locality: _____

_____

_____

	YES	NO
Tin Roof	____	____
Wooden Windows	____	____
Fields next to ponds	____	____

Condition of house: ____ Good ____ Fair ____ Poor

____ kms from house to ponds: _____

____ kms from house to ponds: _____

PONDS:

No.	Length (m)	Width (m)	Area (mxm)	Compost Fence Present (Y/N)	Suffi-cient Water (Y/N)	Observations

1. When did you start raising fish? ____ Before ____ With the Project

2. How many ponds do you have? ____ Total (____ in usable condition)

3. Why did you start raising fish?

____ To get protein/it aids one to have good health

____ To feed my family

____ Because my neighbor was raising fish and was making money on it

____ I could no longer afford to buy fish in the market

____ To make extra money

____ Other: _____

_____

4. How did you learn about how to raise fish or build ponds?

_____

_____

5. Where did you obtain your fingerlings?

THE FIRST TIME		MOST RECENT TIME
_____	Neighbor	_____
_____	Extension Agent	_____
_____	At the fish station	_____
_____	River/Lake	_____
_____	How many fingerlings?	_____
_____	How much did they cost?	_____
_____	How were they transported? (by foot, truck, bike)	_____

How many times after the initial purchase of fingerlings have you had to purchase more from other people? _____

6. Did you encounter any problems in building the ponds? ___ No

____ Uprooting palm trees--Hard work

____ Lack of tools: machete/shovel/coupe-coupe/wheelbarrow/hoe

____ Insufficient water ____ Insufficient labor power

____ Other: _____

7. What problems have you encountered since you started raising fish until now?

____ Obtaining sufficient amounts of fish food

____ Feeding fish: expensive/hard work

____ Lack of material: shovels/machetes/wheelbarrows/axes/ coupe-coupes/nets

____ Finding fingerlings

____ Jealousy of other people

____ Excessive theft: How did they steal? _____

____ People want to buy the fish on credit

____ Other: _____

_____

8. Do others feed jealous because you have ponds? ____ No

____ Yes: How do they express this jealousy? _____

_____

9. Did you have someone else to help you when you built your ponds?

____ No ____ Yes:

____ My Children: Who? _____

____ Friends

____ Hired Workers: How did you pay them?

_____

____ Other: _____

10. Do you want to build another pond?

____ Yes: Why? _____

Where? _____

____ No: Why not? _____

11. Do you plan to increase the capacity of the ponds you already have? ____ No ____ Yes: How? _____

12. When was your last harvest? _____

You harvested the pond after how many months? _____

How many fish did you get? ____ buckets _____

____ bassins _____

____ other: _____

kgs:____ What pond? ____ Area of pond:____ kg/are/year:____

13. At the last harvest did you sell any fingerlings to other farmers?

____ No ____ Yes: Price per fingerling: ____
How many? ____ Total Sale: ____ Z

14. At the last harvest, did you sell all the fish?

____ Yes: Did you get cash?

____ No: only sold on credit ____ Z
____ Yes: in cash ____ Z
on credit ____ Z

Didn't you eat a few of the fish at home? ____ No
____ Yes: How many? _____ ____ kgs

____ No, I sold part of them, ate part of them.

How much cash did you get? _____ Z
on credit? _____ Z
Part eaten at home? _____ ____ kgs

15. Were the fish sold in the market after the last harvest?

____ Yes: In which market? _____
(____ kms from the house to the market)
Who sold the fish? _____

____ No: Where were the fish sold? ____ at pondside
____ on the parcelle
____ other: _____
Who sold the fish? _____

____ No, all the fish were eaten at home.

16. How did you spend the money you made on the harvest?

____ Food/Drink _____

____ Seed: What kind? _____

____ Pay a debt/ Pay school fees/ Pay a tax

____ Buy clothes--for: _____

____ Medicine

____ Loaned money to: _____

____ Trip for: _____ To do what? _____

____ Other: _____

17. Have you ever opened your pond before six months? ____ No

____ Yes: How many times? _____

Why? _____

18. What month is a good time to harvest a pond? _____

_____

Why? _____

To build a pond? _____

Why? _____

To make a lot of money from the sale of fish? _____

_____

Why? _____

19. What month is a bad time to harvest a pond? _____

_____

Why? _____

To build a pond? _____

Why? _____

To make a lot of money from the sale of fish? _____

_____

Why? _____

20. How many times per week do you usually eat fish from your own pond?

_____

_____

Last month (_____) _____

21. How many times per week do you usually eat fish from the market (dried or fresh)? _____

Last month (_____) _____

22. 22. Do you usually eat more fish in the rainy or the dry season?

____ rainy season ____ dry season ____ same

23. What kinds of fish do you buy a lot? Occasionally?
Have you ever bought _____ ?

A LOT		OCCASIONALLY	NEVER
_____	Salted fish (Makaiyabo)	_____	_____
_____	Catfish type	_____	_____
_____	Mikebuka (dried fish from Shaba)	_____	_____
_____	Eels	_____	_____
_____	Fretins (fingerling-sized dry fish)	_____	_____
_____	Canned pilchards	_____	_____
_____	Canned sardines	_____	_____
_____	Tilapia: from neighbors	_____	_____
_____	Tilapia: from the market	_____	_____
_____	Frozen fish (Thompson)	_____	_____
_____	River fish Lulua/Other River	_____	_____

Of all these, which fish do you like the best? _____

24. What other animals do you have? Don't you have any _____ ?

	How many?	Do you feed them? Y/N	What?	Who feeds them?
Chickens	____	____	_____	_____
Goats	____	____	_____	_____
Ducks	____	____	_____	_____
Guinea Pigs	____	____	_____	_____
Pigs	____	____	_____	_____
Guinea Fowl	____	____	_____	_____
Sheep	____	____	_____	_____
Rabbits	____	____	_____	_____
Pigeons	____	____	_____	_____
Cows	____	____	_____	_____

25. What do you feed your fish? Do you feed _____ all the time or sometimes?

Do you feed or have you fed your fish _____ at one time?

ALL THE TIME		SOMETIMES	IN THE PAST	NEVER
____	Manioc leaves	____	____	____
____	Sweet potato leaves	____	____	____
____	Papaya leaves	____	____	____
____	Manioc waste	____	____	____
____	Brewery waste	____	____	____
____	Rice bran	____	____	____
____	Fretins	____	____	____
____	Termites from hills	____	____	____
____	_____	____	____	____
____	_____	____	____	____
____	_____	____	____	____

26. Did you purchase fish food last year? ____ No

(from the month of _____ last year until the month of ____)

What kind?	When?	How much?	Unit	Weight of Unit	TOTAL COST

27. Do you usually compost? ____ No ____ All the time

____ Sometimes

If so, what do you usually put in the compost pit? _____

_____

28. How often do you feed your fish? _____

Who feeds them? _____

29. What do you usually eat every day at home? (1) _____
(2) _____
(3) _____

30. Do you usually prepare your food with wood, charcoal, kerosene, or anything else?

____ wood ____ charcoal ____ wood & a little charcoal
____ kerosene ____ other _____

31. In order to prepare bidia in your home, how do you obtain your manioc flour? _____
Your maize flour? _____

32. In order to feed everyone on this (your) parcelle, how many sacks or bassins of manioc do you need per month? _____

Cost of one sack (one bassin)? _____ Z

In order to feed everyone in this house, how many sacks or bassins of maize grain do you need per month? _____

Cost of one sack (one bassin)? _____ Z

33. Of all work performed within or outside of the household, which one provides the most money? (This is work you or any member of your family does)

	ACTIVITY	WHO PERFORMS THIS ACTIVITY?
First	_____	_____
Second	_____	_____
Third	_____	_____
Fourth	_____	_____
Fifth	_____	_____

(a) Of these activities, which gives the greatest amount of cash for the least amount of labor?

_____

(b) If you were to entirely give up one of your activities (whether in town or in the market), do you think that you could make sufficient amounts of money off of fish ponds to feed your family?

____ No ____ Yes: Why? _____

(c) If you were to give us raising fish, what would you do instead? _____

34. Do you have your own fields? ____ No

____ Yes: Do you sell produce from your fields in the market?

____ No: Not even a small quantity? ____ No ____ Yes

____ Yes: What produce from your fields gives you the most money in the market? | Last year did you get more money from the sale of (1), (2), (3), or the sale of fish?

(1) _____ _____

(2) _____ _____

(3) _____ _____

35. Have you ever worked with an extension agent?

____ Yes: extension agent/ another farmer

____ No: Have you ever heard of Projet Pisciculture Familiale?
____ No ____ Yes

Have you ever tried to contact anyone from P.P.F.?

____ Yes: What happened? _____
____ No: Why not? _____

36. What do you think that P.P.F. should do (now) to help farmers?

____ Show how to raise fish/provide more extension agents
____ Provide credit
____ Provide tools, especially _____
____ Help provide fish food
____ Other: _____

37. Could your bicycle help you to be able to go to the fish station (Katuishi) in order to look at the ponds?

____ Yes ____ No, I don't have one ____ Yes, but it's broken

Does anyone in your family have one you could borrow?
____ No ____ Yes

38. We are thinking of broadcasting lessons on fish culture over the radio. Would you be able to listen on your own radio or a neighbors?

____ my own ____ a neighbor's ____ mine is broken

39. When did you begin living on this parcelle? _____

40. Who lives or has lived in this household during the past year? (everyone who eats there on a regular basis)

PONDS:				FIELDS:	
1	Clearing	5	Maintenance	9	Clearing
2	Construction	6	Harvesting	10	Planting
3	Composting	7	Marketing	11	Weeding
4	Feeding	8	Other	12	Harvesting
				13	Marketing
				14	Processing

No.	Name	Relationship to head of household?	Sex	Age	Educational Level Now?	# of Years	Do you cultivate? Y N	Activity	Do you work on ponds? Y N	Activity

APPENDIX B

FIGURE B1. PERCENTAGE OF HOUSEHOLD MEMBERS WHO EVER STUDIED (INITIAL ADOPTERS, SECONDARY ADOPTERS, AND DROP-OUTS)

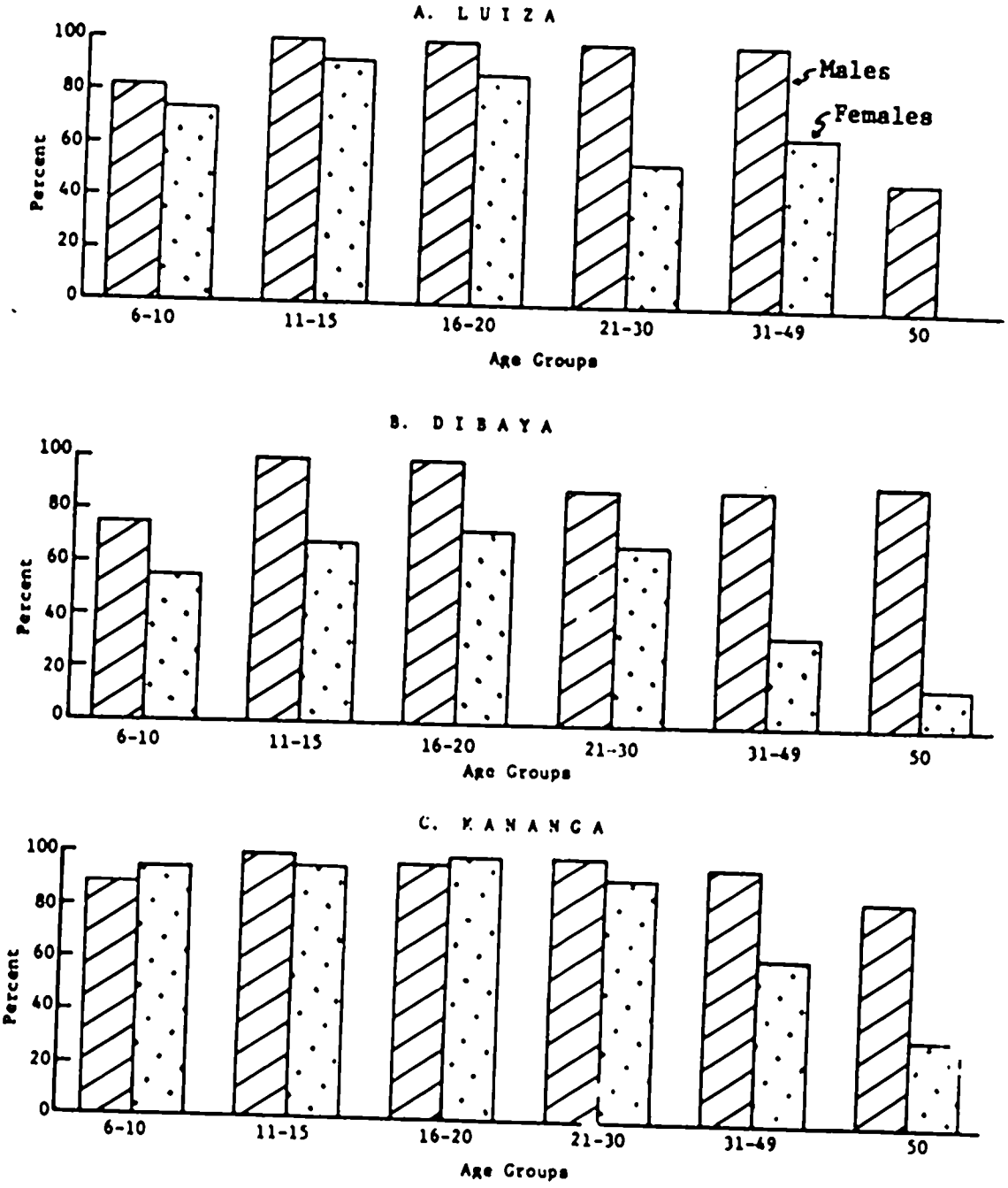
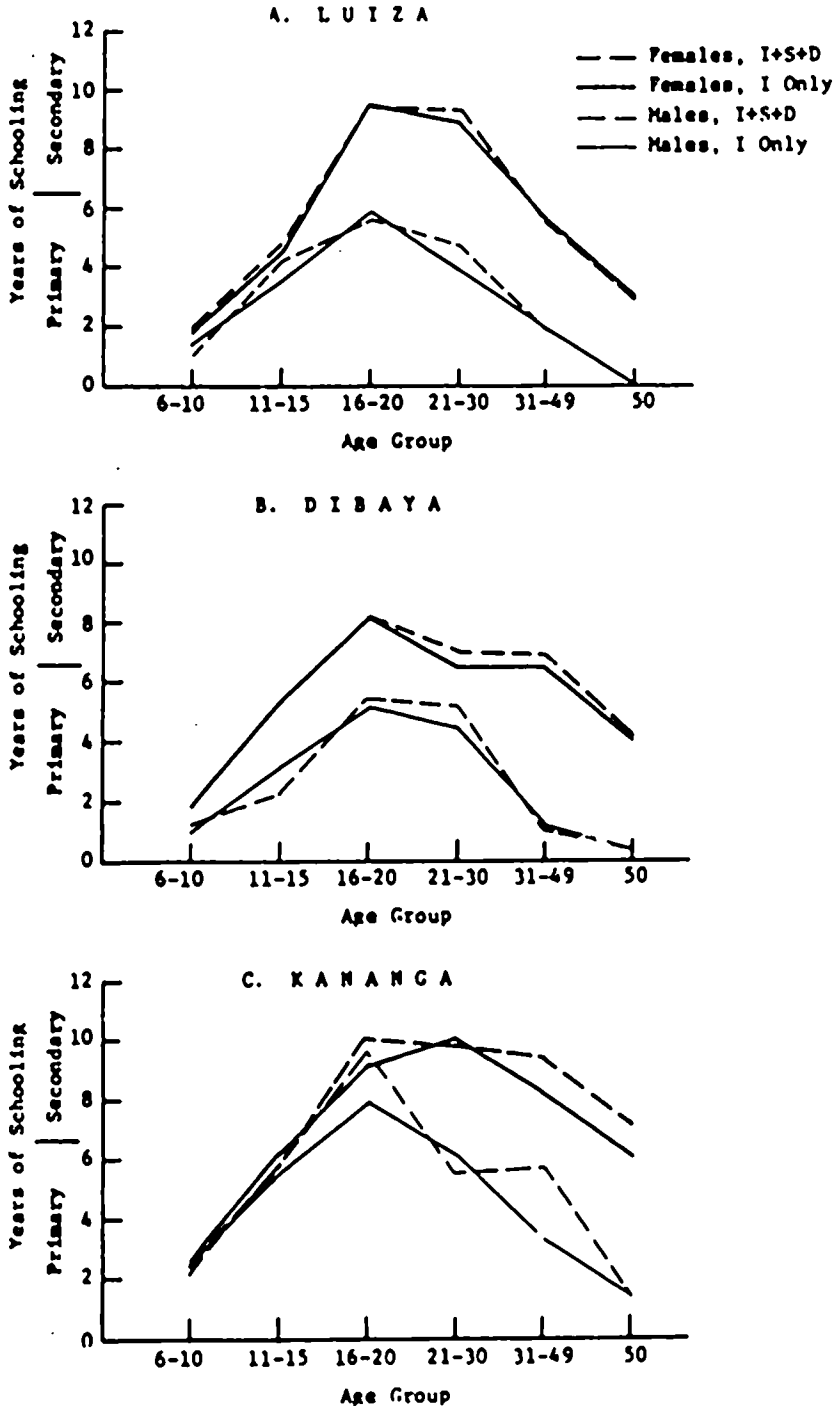


FIGURE B2. MEAN EDUCATIONAL LEVEL OF HOUSEHOLD MEMBERS WHO HAVE EVER STUDIED



I: Initial Adopter Households; S: Secondary Adopter Households;
D: Drop-out Households

APPENDIX C

Monthly Base Salaries for Government Employees[a]

(1978 through 1983)

No.	Administrative Position	Average Base Salary (in Zaires)					
		1978	1979	1980	1981	1982	1983
1	Secretaire-General	6000	6000	8000	8000	10000	12000
2	Directeur	3000	3000	3000	3500	4000	6000
3	Chef de Division	1200	1200	1250	1500	2000	3000
4	Chef de Bureau	1000	1000	1150	1200	1400	1800
5	Attache de Bureau 1e Class	600	600	650	700	800	900
6	Attache de Bureau 2e Class	350	350	400	500	700	850
7	Agent de Bureau 1e Class	300	300	350	400	500	600
8	Agent de Bureau 2e Class	200	200	250	300	350	381
9	Agent Auxillier de 1e Class	175	175	200	230	260	295
10	Agent Auxillier de 2e Class	150	150	190	220	240	280
11	Huissier (Worker)	120	120	150	180	200	254

[a]Data from Institut National de la Statistique, Kananga. Base salaries listed do not include payments for lodging, additional family, or transport.