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A QUALITATIVE EVALUATION OF ALTERNATIVE DEVELOPMENT STRATEGIES FOR UGANDAN FISHERIES

by

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A Contribution to the Strategic Criteria for Rural Investments in Productivity (SCRIP) Program of the USAID Uganda Mission

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ABBREVIATIONS

EU – European Union

DFR – Department of Fisheries Resources

FIRRI – Fisheries Resources Research Institute

IITA – International Institute for Tropical Agriculture

LVEMP – Lake Victoria Environmental Management Project

LVFRO – Lake Victoria Fisheries Research Organisation

MSY – Maximum Sustainable Yield

NARO – National Agricultural Research Organisation

NRI – Natural Resources Institute

PSF – Private Sector Foundation

SPEED – Support for Private Enterprise Expansion and Development

UCFFA – Uganda Commercial Fish Farmers Association

UFPEA – Uganda Fish Processors and Exporters Association

ABSTRACT

The fisheries sector contributes greatly to the Ugandan economy in terms of income; employment and export revenue; yet recent developments, especially the reducing fish stocks, are posing a big threat to the sector. This study was carried out to assess the current status of the Ugandan fisheries sector, suggest alternative development strategies, and evaluate their impacts on livelihoods, export revenues, and the environment. Data used in the study were obtained from the Department of Fisheries Resources, the Aquaculture Research and Development Center, Fisheries Resources Research Institute, and through a review of literature. Interviews were held with many actors in the sector. Development strategies were evaluated in terms of market conditions, technical constraints, and institutional constraints.

There are indications that excessive fishing effort and the use of unsustainable fishing methods over the last decade have resulted in over exploitation of the resource above the maximum sustainable yield, due in part to ineffective national and regional regulation. Fish stocks have subsequently diminished, leading to less catch per boat and stagnation in total fish production at around 220,000 tones. In contrast, the demand for Ugandan fish in local, regional, and international markets continues to grow. Fishermen incomes have reduced tremendously, processing plants are operating below installed capacity, local processors/traders are being forced out of business, and less fish reaches consumers.

Four Alternative development strategies for the Ugandan fisheries sector are identified: (1) Decreasing the supply of wild catch Nile perch to sustainable levels and then keep it constant, through stock regulation; (2) Increasing the supply of Nile perch of export quality through: (a) the introduction and promotion of cage/pond aquaculture or (b) Nile perch lake stock replenishment; (3) Increasing the supply of fish (Tilapia, Catfish, etc) for domestic and regional markets through (a) pond aquaculture, and (b) stock replenishment; and (4) Increasing the competitiveness of Ugandan fish supply chain by reducing the cost of production, transport/handling, and processing, and by improving product quality.

Strategy 1 is likely to lead to the recuperation of fish stocks and thus increased revenue in the long run, although at the cost of reduced income in the short term. Its implementation will require increased, joint efforts by the Department of Fisheries Resources and the Lake Victoria Fisheries Research Organisation in national and regional regulation, requiring more resources (personnel, funds, equipment) and collection of better data on fish stocks, effort level, fish reproductive biology and resilience potential. Strategy 2 is likely to increase the supply of export quality fish, generating more export revenue and increasing access to fish by the poor. This strategy requires investments in developing Nile perch breeding technology in captivity and in research on the environmental impact of lake cage aquaculture. Strategy 3 is likely to lead to increased fish supply in local and regional markets, higher incomes to fish farmers or fishermen, and improved access to fish by the poor. While technologies are already available for breeding and farming Tilapia and Catfish, expansion of this aquaculture is constrained by low extension efforts and inadequate fry (feed) production. Strategy 4 will increase both the quality and quantity of fish as well as incomes, but its implementation would require considerable investments in infrastructure and new technologies. Increasing the efficiency of the supply chain for fish of export quality may reduce the quantity of fish available to local traders and processors.

Key words: Uganda, Lake Victoria, freshwater fisheries, aquaculture, Nile perch, development strategies, evaluation.

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1.0 INTRODUCTION

1.1 BACKGROUND

The fisheries sector contributes greatly to the Ugandan economy in terms of income, employment and export revenue. In 2002, this sector contributed about UShs 210,000 million or 2.4% of the gross domestic product (MFPED, 2003). Fish is a protein source for 24.7 million people in Uganda (UBOS, 2002) and other consumers in the East African region. It is estimated that the fisheries sector employs 500,000 – 1,000,000 Ugandans, including fishermen and fish farmers, fish processors and processing plant workers, transporters, traders (categorized in the fish trade by mode of transportation: bicycle, pick-up, boat) and factory agents, gear manufacturers, and boat makers (Patrick Nugawela, personal communication, 2003).

Fish emerged as a non-traditional export commodity in the late 1980's, with export earnings increasing from US$ 1 million in 1989 to US$ 45 million in 1996. In 2001, 28,700 tons of factory processed fish were exported generating US$ 80.4 million and in 2002, 25,200 tons were exported generating US$ 87.57 million (DFR, 2003). This makes fish the second largest foreign income source after coffee, contributing 19% of total export earnings in 2002 (MFPED, 2003). The main export markets are the European Union, Australia, the Middle East, United States, Egypt and South-East Asia (UFPEA, 2003). Nile perch (*Lates niloticus*) products represent over 90% of exports (Yogesh Grover personal communication, 2003), where consumers demand it for the presence of key omega-3-fatty acids, which have a beneficial effect on cholesterol levels, and for the palatable bone-free white flesh (David Tilia personal communication, 2003).[i]

1.2 PROBLEM STATEMENT

The demand for Ugandan fish has increased dramatically over the last two decades due to rapid domestic population growth and the emergence of an export market for especially Nile perch and Nile tilapia (*Oreochromis niloticus).* Globally, fish consumption has doubled since the early 1970's, and developing countries are responsible for over 90% of this growth (Delgado et al., 2003). In Uganda, the nominal producer price of export quality Nile perch has risen from UShs 300 per kg in 1990 to

UShs 2,000 per kg in 2002 (Department of Fisheries Resources, personal communication, 2003). The increase in the price and demand for Ugandan fish led to increased fish production and productive capacity and to the establishment of modern export fish processing plants. This has in turn caused increased fishing pressure in Uganda's three largest lakes (Victoria, Kyoga, and Albert). Due to the lack of reliable and repeated stock assessments, the trends or levels in the fish biomass in Uganda's lakes cannot be established with certainty. Nevertheless, the significant decline in the average size of fish (mainly Nile perch) caught to well below maturity (spawning) age is a strong indication that harvest levels for some time, possibly since the early 1990s, have been well above the maximum sustainable yield (MSY) level (CARANA Report, 2002) and that upholding this pressure will lead to a further deterioration in the size and structure of the fish biomass.[ii] Another sign of declining biomass is the stagnation of total production observed since 1995 (Odongkara, 2001) despite an increase in fishing effort (number of boats and nets in operation). Some fisheries sector observers believe that the Nile perch fishery might collapse around 2007 if current exploitation levels are maintained (COMPETE, 2002).[iii]

Increased fishing effort in a situation of declining or constant fish stocks has resulted in a significant decline in the productivity and profitability of fishing and fish processing (CARANA Report 2002). These developments suggest that there is a significant and possibly growing welfare problem, which needs to be addressed by government and fishery industry organizations. The question is how best to prevent further reductions in income, employment and returns to investments in production and processing equipment that will follow from a continuation of the downward trend in fish stocks.

1.3 OBJECTIVES AND METHODS

The goal of this study was to generate knowledge needed for the development of strategies, policies and institutions for the growth of Uganda's fisheries sector while ensuring sustainable fish resource utilization and equity among all actors. The three research questions were: (i) What is the current status of Uganda's Fisheries sector (production, production technology, production constraints, profitability - fishermen,

local processors and traders, handling and processing)? (ii) What are the possible development strategies for the Ugandan fisheries sector? (iii) What are the possible impacts of the proposed development strategies for Uganda's fisheries industry on livelihoods and export revenue?

Data used to assess the current status of Uganda's fish sector was collected through interviews and secondary data from reports. Fish resource and production data were obtained from the Department of Fisheries Resources (DFR) and the Aquaculture Research and Development Center, Kajjansi. Trade and profitability data were obtained from the Fisheries Resources Research Institute (FIRRI) survey reports and the International Institute for Tropical Agriculture - IITA/Natural Resources Institute - NRI Transaction cost analysis study (IITA/NRI, 2002). Interviews were held with fish processors/exporters and other agents in the fish sector. Based on the opportunities and constraints, suggestions are made for Ugandan fisheries sector development strategies and their impacts are qualitatively evaluated, focusing on the potential benefits/losses of alternative strategies in the Ugandan fisheries sector while devoting less attention to how and at what costs the strategies are implemented.

1.4 ORGANIZATION OF THE REPORT

The next section of the report explores the current status of the fisheries sector in Uganda covering markets, trade, resources, infrastructure, fish production, handling, processing and regulation of the fishing/processing activities. Section three of the paper looks at the constraints, opportunities and possible development strategies for the industry. In section four, the formulated development strategies are qualitatively evaluated based on the market conditions, technical and institutional constraints, and impacts on income, poverty and the environment. Section five covers the policy implications and areas that require more research, and six the conclusions.

2.0 SOCIO-ECONOMIC CHARACTERISATION

2.1 MARKETS AND TRADE

2.1.1 Domestic and Regional Markets

Ugandans consumed an estimated 162,430 tons of fish annually from 2000 to 2002, representing 74% of total fish catch (Table 1). Fish provides 40–50% of the total animal protein intake of Ugandans, who have a strong culture for fish consumption (Jagger and Pender 2001). The average annual fish consumption per capita has been estimated at 12.7 kg (Kigeya 1995, cited in Jagger and Pender 2001), while calculations based on the Uganda National Household Survey (1999-2000) gives a figure around 7 kg per person (Bolwig et al., forthcoming). Minimum fish requirement according to the FAO is 10 kg per year. In 2002, the average local retail price of fresh Nile perch was UShs 1,730 per kg while smoked Nile perch was sold at UShs 940 per kg. The retail price for fresh Tilapia was UShs 1,470 per kg whereas smoked Tilapia was sold at UShs 1,063 per kg. These figures hide great variations between landing sites, due to differences in accessibility and related transportation costs, and the quality of fish. The variations in prices are fully explored in the proceeding section.

Expected increases in population and per capita income are likely to substantially increase total demand for fish in Uganda over the next 10–15 years. The income elasticity of demand for fish is high compared to other food items (Pender and Jagger 2001) and is likely to be similar to the 1.035 estimate by USDA (2004) for Tanzania (a country similar to Uganda in terms of income and food consumption patterns). Assuming that Uganda maintains its current rate of growth in real GDP of 5.0% per year (Bank of Uganda 2004), or the 2.9% per year achieved in 1998-2002,[iv] we may expect a significant increase in fish consumption from the combination of high income growth and high income elasticity of demand. With a population of 24.7 million in 2002 and an annual growth rate of 3.4% over the previous decade, a large increase in Uganda's population is expected during this period. In combination these trends predict a very significant increase in the total domestic demand for fish to 2015. According to NARO (1996), Uganda will have an annual deficit of 124,000 tons of fish by the year 2010 at current production levels.

Table 1. Trends In Fish Exports And Domestic/Regional Consumption, 1996-2002

Year	Total fish catch [1]	International exports	Domestic and regional consumption [1]	Value of international exports
	tons	*tons*	*tons*	*million US$*
1996	218,000	16,396	201,604	39.78
1997	218,000	9,839	208,161	28.80
1998	217,000	13,755	203,245	34.92
1999	229,000	13,370	215,630	36.61
2000	219,000	15,876	203,124	34.36
2001	221,000	28,672	192,328	80.41
2002	222,000	25,160	196,840	87.57

Notes: [1]Estimates. Domestic and regional consumption include the by-products from fish processing factories. Data sources: DFR and MAAIF fish sector sheets (2003); Market development report (SPEED, 2003; confidential draft).

Regional trade in smoked and sun dried fish contributes substantially to Ugandan foreign exchange earnings (Table 2) and household incomes. The main destinations are DR Congo, Rwanda and Kenya (FIRRI, 2003). The species traded include Nile perch, Nile tilapia, Mukene, Catfish, Hydrocynus and Alestes. Due to the high demand for fish in the region and stronger enforcement of the ban on trade in immature fish, fish processing by-products (skeletons and heads) are increasingly being smoked and sold to neighboring countries. Some industrial processors have also started exporting fillets in small quantities, mainly to DR Congo and Rwanda (Amongin, personal communication, 2003), while others have begun to supply fillets to local schools. This suggests an increasing role of industrial processors in the domestic and regional markets. Like in the domestic market, regional consumption of fish is expected to experience high growth due to increases in population and income. Von Braun et al. (2004) predict that the annual consumption growth rates in East Africa (Burundi, Kenya, Rwanda, Tanzania, Uganda) between 1997 and 2015 will be 1.9% for high-value (more expensive types of) fish and 2.2% for low-value fish.

Table 2. Annual regional fish exports from Uganda, 2002

Country	Border	Volume	Value	Value	Unit value
		tons	*'000 UShs*	*US$*	*US$/ton*
DRC	Panyimur	392.46	415,965	231,477	590
	Bunagana	1,349.69	446,998	248,747	184
	Mpondwe	2,890	5,541,973	3,084,014	1,067
	Mpondwe (by-products)	244.8	361,620	201,235	822[1]
	All	*4,876.95*	*6,766,556*	*3,765,474*	*Average: 772*
Rwanda	Katuna	596.3	289,443	161,070	270
Kenya	Malaba CBP	522	522,000	290,484	556[2]
	Busia	906.6	1,092,966	608,217	671
	Busia (direct truck)	79.2	185,262	103,095	1,302
	All	*1,507.8*	*1,800,228*	*1,001,796*	*Average: 664*
Grand Total		**6,981**	**8,856,227**	**4,928,340**	**Average: 706**

Source: FIRRI, April 2003. Survey of the Regional fish trade. Exchange rate in 2002: 1$=1997 UShs. [1] Skins make up 144.6 tons worth 216.9 million UShs. [2] Value calculated based on estimated price of 1000 UShs/kg fresh tilapia.

2.1.2 International Export Markets

Fish exports are a major source of export revenue for developing countries, totaling over US$20 billion per year in the late 1990's (FAO, 2003). High EU demand for Nile perch and, to a much smaller extent, Nile tilapia, and the establishment of 10 modern fish processing plants during the 1990s, have allowed fisheries to become Uganda's second most important export commodity after coffee. In 2002, Uganda exported 25,160 tons of processed fish to countries outside the region, earning US$ 87.57 million (Table 1). The exported products include frozen fillets, chilled fillets, whole frozen fish, frozen gutted and headed fish, and dried fish maws (Table 3).

Table 3. EU imports of Nile perch by product type, 1997 – 2003

Product		Unit	1997	1998	1999	2000	2001	2002	2003
Fresh	Value	*'000 Euro*	58,483	39,642	23,190	99,675	149,591	164,760	141,302
Fillets	Quantity	*Tons*	14,453	9,708	5,613	22,985	33,487	31,767	36,161
Frozen	Value	*'000 Euro*	29,008	42,390	8,353	25,766	25,572	29,529	28,583
Fillets	Quantity	*Tons*	10,671	14,138	2,820	7,354	7,099	7,536	8,952
Total value		*'000 Euro*	**87,491**	**82,032**	**31,543**	**125,440**	**175,163**	**194,289**	**169,884**
Total quantity		*Tons*	**25,124**	**23,846**	**8,433**	**30,338**	**40,586**	**39,303**	**45,113**

Source: EUROSTAT, 2004

Spain and Portugal are markets for both fillets and headed and gutted Nile perch while Italy, Germany, Austria, France, Belgium and the Netherlands are currently stable markets for fillets. The quantities imported by the EU countries are given in Table 4.

Table 4. EU Imports of Nile Perch Fillets by Member Country, 1997 – 2003

Country	1997	1998	1999 [1]	2000	2001	2002	2003
				tons			
Austria	-	-	107	-	-	1,628	5,638
Belgium - Luxembourg	9,988	11,183	-	-	-	-	-
Belgium	-	-	2,868	17,038	25,354	16,890	13,371
Denmark	-	-	-	-	-	563	406
Germany	2,629	1,043	812	431	1,329	1,946	4,197
France	146	416	31	30	116	44	272
Greece	3,157	3,018	629	1,407	1,533	2,149	2,291
Italy	379	504	76	218	653	1,227	740
Luxembourg	-	-	238	784	1,520	1,066	1,263
Netherlands	8,184	6,086	2,438	9,111	9,186	11,204	14,509
Portugal	201	365	88	432	174	325	676
Spain	394	1,156	1,123	871	705	1,123	1,704
Sweden	32	35	16	16	16	1,137	24
UK	15	40	9	-	-	3	22
Grand Total	**25,124**	**23,846**	**8,433**	**30,338**	**40,586**	**39,303**	**45,113**

Source: EUROSTAT, 2004. [1] EU fish ban affected imports.

New EU member countries like Slovenia, Hungary and Poland could also become interesting markets for Nile perch in the near future (Josupeit, 2004). In 2003, total imports into the EU reached a new record of 45,000 tonnes, with Belgium and Netherlands as the main importers. Sixty percent of this comes from Tanzania, 30% from Uganda and 10% from Kenya. The industry faces no major demand or market access constraints after having met EU sanitary standards, particularly on documentation. This effort followed bans on fish imports from Uganda during 1997–99, which were imposed due to fears that Ugandan fish were contaminated with salmonella, cholera and pesticide residues. The bans caused a drop in exports (Table 1 and 4) and loss of export revenues for Uganda was estimated at about US$ 38 million in 1999 (DFR, personal communication, 2003).

The average export prices for Nile perch were US$ 3.7 per kg in 2000, US$ 3.0 in 2001 and US$ 3.6 in 2002. In comparison, retail prices in the EU are about US$ 9.0 per kg. The difference is attributed to EU sales taxes and high transportation and distribution

costs. The cost of airfreight from Uganda is relatively high (minimum 1.5 $/kg to Europe, half of that from Ghana, for example) due mainly to low freight capacity, something that greatly reduces export prices. Also, Nile perch is sold at the lower end of the market segment, mainly as a substitute for cod, which may negatively affect Ugandan export prices. Fish of export quality is acquired by the processors from Uganda's three major lakes, but mainly Lake Victoria. In 2002, the average buying price for Nile perch was UShs 1,980 per kg at landing sites on Lake Victoria, UShs 1,170 per kg for sites on Lake Kyoga, and UShs 950 for sites on Lake Albert. Poor accessibility and poor handling infrastructure (resulting in large post-harvest losses) account for the lower prices on Lake Kyoga and Lake Albert.

The demand for Nile perch in high income countries is increasing. Global demand for high value fish grows relatively slowly (0.9% per year), but its price is nevertheless projected to increase albeit at a slow rate (0.6%). Delgado et al (2003) project a decline in net fish exports from developing countries to high income countries during 1997-2020, due to general income increases in developing countries and the emergence of a middle class able to purchase high value fish. The European Union, Uganda's most important market, has streamlined catch quotas and enacted several conservation and better fishery management measures following heavy exploitation of fish stocks in Europe. These steps have resulted in reduced production and less fish reaching the European consumer. This has lead to increased dependence on fish imports (Nile perch and Nile tilapia fillets) particularly from low income countries and over exploitation of their fish resources to meet the protein demand. The most recent increases in EU fish imports have been attributed to the mad cow disease and the reduction in the stocks of Cod and Haddock. The passing of the Africa Growth Opportunities Act (AGOA) has created possibilities of accessing new markets in the USA. In these and other markets, Nile perch faces competition from farmed tilapia (China and Vietnam), Catfish from Vietnam and slightly similar species from Japan (Amongin and Johny, personal communication, 2003).

2.2 UGANDA'S FISH SUPPLY CHAIN

Four types of actors dominate the fish supply chain: the primary producers (fishermen), the traders and factory agents, the local (artisan) and industrial processors,

and the regional and international exporters (Figure 1). The fishermen land their catch at the various landing sites on the lakes. Some fishermen have strong commercial links with industrial processors, boat traders, and factory agents who buy export quality fish. Fish merchants and boat traders are middlemen who use mainly motorized and iced boats. They buy export-quality fish directly from fishermen on the Lake Victoria islands or at inaccessible landing sites, and transport it to other landing sites for sale to processing factories. Transport boat operators commonly own several fishing boats in the islands and transport fish together with other merchandise. In most cases, the processors provide ice to fishermen and boat traders. After the fish is processed, industrial operators sell the fish to exporters or directly to overseas importers. Frozen fish is exported by road/sea and chilled fish by airfreight from Entebbe. Most of the fish for regional trade is smoked/salted.

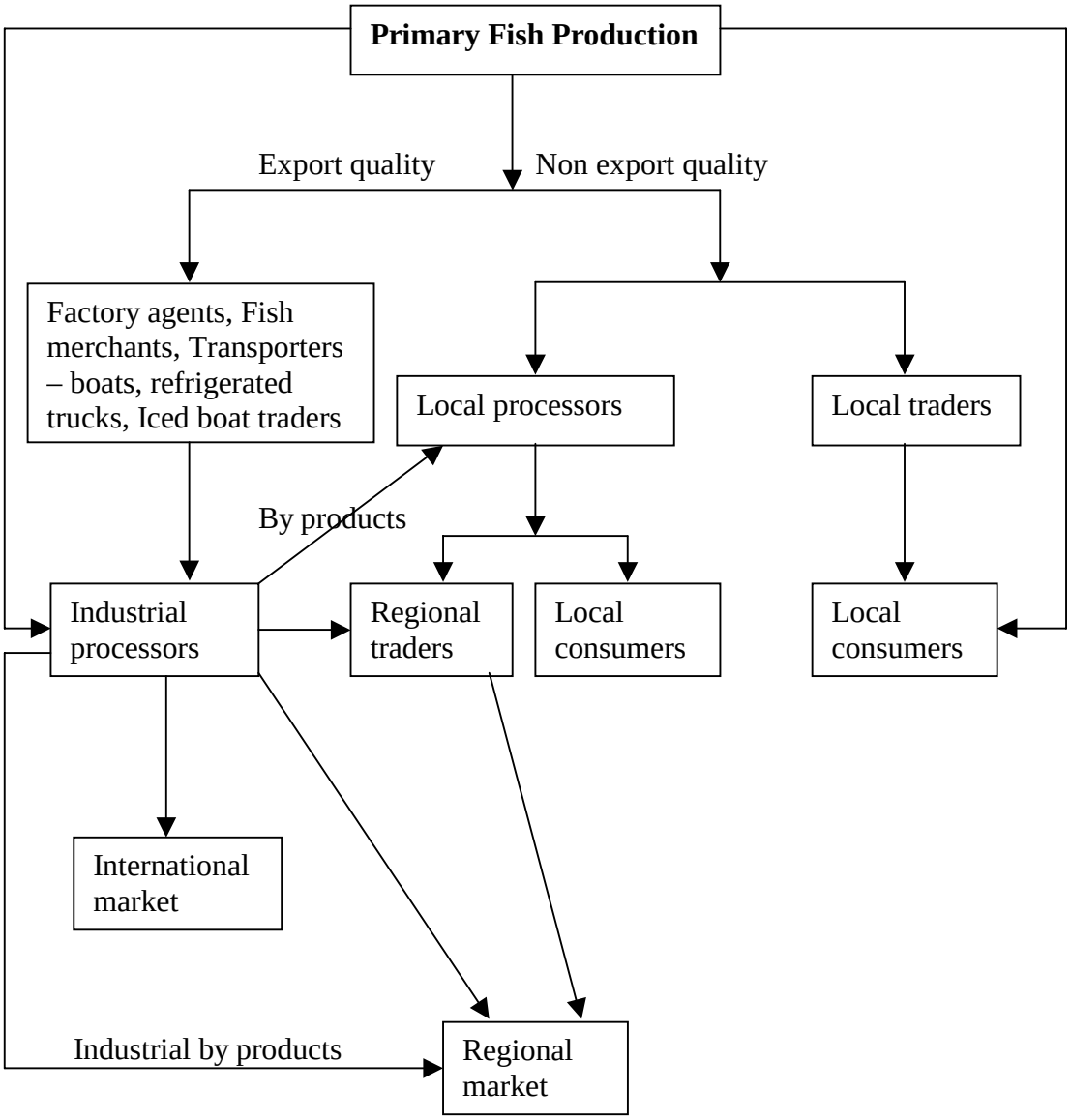


Figure 1. Uganda's Fish Supply Chain.

2.3 FISH RESOURCES

The vast majority of Uganda's fish resources are concentrated in the three largest lakes[v] (Victoria, Kyoga and Albert) while the contributions from minor lakes and fish ponds are negligible. We therefore focus on the former resource. Uganda's water bodies cover about 42,383 km^2 out of a total surface area of 241,038 km^2. The major capture lakes are Victoria, Kyoga and Albert. Lake Victoria has over 180 fish species and

contributes 60% of the national fish catch. Lake Kyoga has 68 fish species and contributes 25%, and Albert 9% of the national catch (DFR, 2003). The major commercial species caught from these lakes are Nile perch, Nile tilapia and Mukene *(Rastreneobola argentea).* Nile perch was introduced into these lakes (Victoria, Kyoga and Nabugabo) to feed on the small sized abundant haplochromine cichlids (Nkejje) and convert them to larger table fish. It can grow up to 200 kg but the minimum legal harvestable size is about 2 kg (50 cm total length). Water bodies in Uganda are open access resources,[vi] with the exception of Lakes Edward and George where boat numbers are controlled and legal gillnet sizes enforced. Fish production is highest during the rainy seasons (March to June and August to December), which is the spawning period. In addition to the natural water bodies, there are about 1,500,000 m^2 of pond area with a potential yield of about 12,000 tons of tilapia (NARO/FIRRI, 2000).

Recent developments in the fish sector suggest a reduction in fish resources in the lakes. The key indicators/evidence include:

(i) Estimation by the Lake Victoria Fisheries Research Project (LVFRP) that 95% of the Nile perch biomass is below 50 cm in total length (legal size for harvesting), implying that fish for processing and local/regional consumption comes from a very limited percentage of total biomass. It also implies that the number of adults available for reproduction is small.

(ii) More fishing boats, less catch. Catch levels per boat per day have reduced from about 80 kg in the late 1990's to less than 40 kg (CARANA Report, 2002). The profitability has subsequently reduced (Odongkara, 2001; FIRRI, 2002).

(iii) Stagnation of national production at about 220,000 tones per year.

(iv) Majority of the processors are operating at about 50% of their processing capacity.

2.4 PHYSICAL INFRASTRUCTURE

It is estimated that Lake Victoria has about 600 landing sites, of which about 30% can be accessed by motor vehicles. Only eight sites have been gazetted and upgraded to handle fish for export, although processors often buy from non-gazetted sites. Accessibility of landing sites on Lakes Kyoga and Albert is poor due to bad roads.

Transportation of fish from these lakes to the processing plants is therefore more costly compared to Lake Victoria. There are ten fish processing plants, six of which are in Kampala and others in Jinja, Entebbe and Kalisizo (Table 5).

Table 5. Location and Capacity of Industrial processing plants

Fish processor location	Number of processors	Daily average installed capacity (tones)	Av. Capacity utilization (%)
Kampala	6	48	48
Jinja	2	35	43
Entebbe	1	25	68
Kalisizo	1	60	50
Total	10	443	--

Data source: Uganda Fish Processors and Exporters Association, 2003.

The rapid investment in fish processing for export has led to industrial processing capacity exceeding the government licensed quota of 135 tons daily intake of raw material by about 308 tons in 2002/03. Due to the shortage of fish of export quality, all industrial processing plants are operating below their installed capacity (Table 5) and compete with each other for the dwindling fish resources. The plants are nevertheless still generating substantial revenues and are an important source of employment for the local population (Table 6).

Table 6. Industrial Fish Processing Plants Categorized By Export Earnings

Fish Processing Plant Size Category		Export Earnings *(billion UShs/yr)*			No. of Employees		
Annual export earnings (billion UShs)	*Number*	*Sum*	*Average*	*Range*	*Sum*	*Average*	*Range*
1 – 15	4	29.5	7.4	3.2 – 11.0	851	213	148 - 280
15 – 30	3	49.1	16.4	15.9 – 16.8	640	213	190 - 230
> 30	3	111.6	37.2	30.5 – 45.8	1159	286	324 - 465
Total	10	190.2			2650		

Data source: Uganda Fish Processors and Exporters Association, 2003.

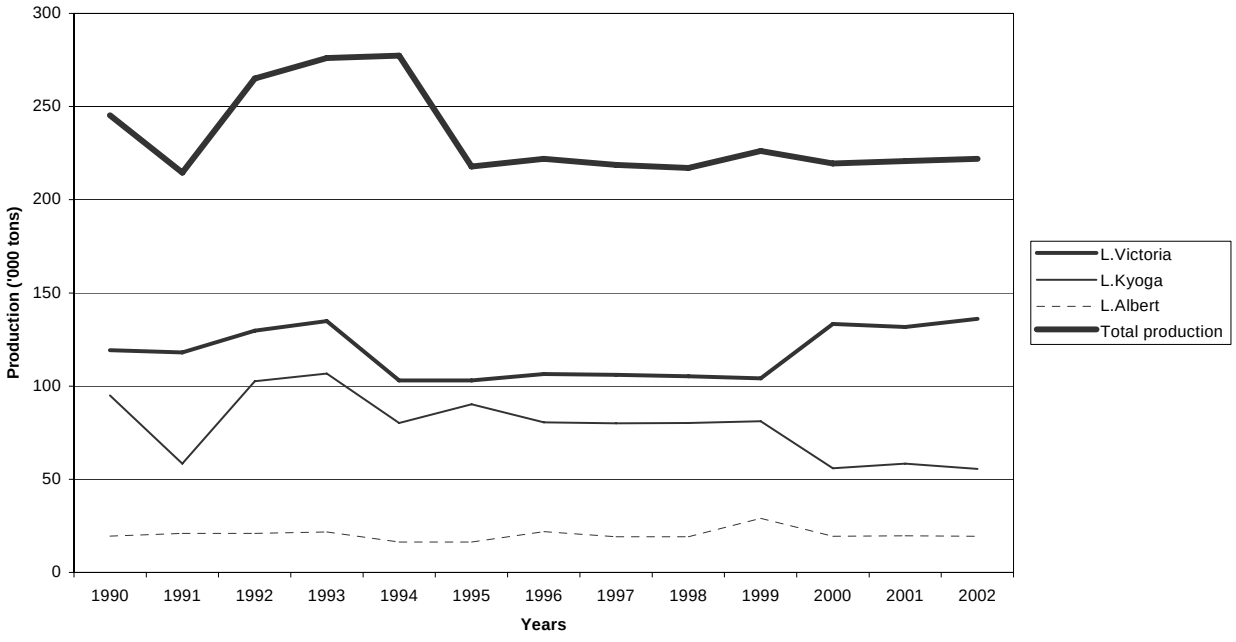
2.5 PRODUCTION, TRANSPORT, AND PROCESSING

2.5.1 Fish Production

National fish production was 221,890 tons in 2002, valued at over UShs 73.05 billion with Nile tilapia and Nile perch contributed 44.1% and 40.8%, respectively, to this value (Department of Fisheries Resources, 2003). Fishing has been an important economic activity for communities surrounding Uganda's water bodies throughout the

20th century. Fish production has increased in recent decades due to the introduction of Nile perch and Tilapines into Lakes Kyoga, Victoria and Nabugabo from Lake Albert in the late 1950's and early 1960's. The annual rate of increase in production has diminished over the last three decades: it was 1.2% in 1970–80, 2.8% in 1980–90, and 0.6% in 1990–2000 (DFR, 2003). In comparison, in 1985-1997 the annual growth rate was 3.2% for sub-Saharan Africa as a whole (Delgado et al., 2003). Figure 2 shows fish production in Uganda between 1990 and 2002. The sharp increase in production between 1990 and 1994 is attributed to the increase perch biomass and production investments as the export market emerged. In 1994–1995, total production fell sharply to the 1991 level, and has not since recovered, possibly due to the reduction in fish stocks and the water hyacinth. The output from Lake Victoria increased sharply when the ban on EU fish imports was lifted in 2000, but this gain was offset by a fall in production in Lake Kyoga, caused by fish stocks reduction and water hyacinth, and possibly a shift in fishing effort from Lake Kyoga to Lake Victoria in response to improved opportunities in the latter.[vii]

Figure 2. Uganda's Fish Production from 1990-2002 ('000 tons).



Source: Department of Fisheries Resources, DFR

2.5.2 Production Technology and Capacity

Uganda's fisheries are predominantly artisan. Fishermen use wooden boats, gillnets, and longlines. Gillnetting is a common passive fish capture method and affects the quality of fish as compared to active methods like trawling. A large proportion of the fishermen on Lake Victoria reside and operate from the several islands in the lake. The increasing demand for fish since the late 1980s has resulted in a greatly enhanced production capacity, especially in Nile perch fishing on Lake Victoria. The number of fishing boats thus increased from 8,000 in 1990 to 20,000 in 2002, involving the entrance of many new producers and a shift from part-time to full-time fishing for many fishermen (COMPETE, 2002). An estimated 15% of fishing boats are motorized, the rest being powered manually with or without sails. It is common to find individuals owning more than one fishing boat. Share tenancy arrangements are as common as the hiring of boats and engines for cash. The gillnets in operation on Lake Victoria also increased, from 75,300 to 290,000 between 1990 and 2000 (COMPETE, 2002), while the size of the nets increased to enable fishermen catch large size Nile perch (10–30 kg). These investments have led to a greatly intensified competition for the same or a smaller amount of fish. Unlike in Kenya and Tanzania, trawling is not practiced by Ugandan fishermen on Lake Victoria. This technology may improve the reach, cost effectiveness, and fish quality but will lead to the loss of employment of thousands of smallholder fishermen.

2.5.3 Profitability of Fishing, Transport, Processing, and Trade

The decline in fish catch (boat productivity) mentioned earlier appears to have reduced profitability especially for large investments in fishing gear, boats and engines. For example, the catch for fishermen with motorized boats is twice that of the non-motorized boats.[viii] However, the higher variable costs of production associated with motorized boats imply that Nile perch fishermen with motorized boats now earn smaller net revenues[ix] than those using non-motorized boats (Table 7). The immediate remedy would be to reduce the variable costs of production, but a further reduction in stocks is likely to reduce profitability more. Fishermen on lake Kyoga are earning slightly more, but a reduction in fish stocks has already been reported (Twongo, 2002). The high profitability of fishing on Lake Albert shown in Table 7 confers with statements by

fisheries officials that the lake still has large fish stocks. Controlled investments in production on this lake coupled with an improvement in infrastructure can increase fish supply. Nile perch smokers operating on landing sites on Lake Victoria appear to be operating at a loss because of the high price of non-factory quality fish. Nile perch smokers on Lake Albert buy more fish at slightly lower prices and get higher net revenues due to the large market for smoked fish in neighboring DR Congo (Table 7). Already a number of fish smokers on lake Victoria have lost their jobs.

Factory agents on lake Victoria are earning more than the motorized boat entrepreneurs indicating that selling directly to the processors could offer a big advantage to the fishermen, but may require strong networks. Boat traders on Lake Kyoga enjoy large net revenues, due to poor accessibility of most landing sites and rebel activities that has affected businesses on the northern shores of the lake.

Table 7. Profitability of *Nile perch* production, local processing and trading at selected landing sites on Lake Victoria, Kyoga and Albert (UShs) [1]

		Lake Victoria		Lake Kyoga		Lake Albert	
Category	**Variable**	**Accessible**	**Non-accessible to fish trucks**	**Accessible**	**Non-accessible to fish trucks**	**Accessible**	**Non-accessible to fish trucks**
Motorized fishing boats	Investment	5,020,937	-	-	-	-	-
	Catch (kg/month)	551	-	-	-	-	-
	Selling price/kg	2,000	-	-	-	-	-
	Net revenue	23,628	-	-	-	-	-
Non-motorized fishing boats	Investment	1,746,643	*	821,088	108,000	555,175	309,911
	Catch (kg/month)	297	*	477.82	75	863.25	1,434
	Selling price/kg	1,970	*	1,170	1,000	950	800
	Net revenue	237,220	*	248,473	2,000	350,975	904,287
Fish smokers	Investment	45,375	-	74,583	-	43,100	26,833
	Quantity (kg/month)	57	-	528	-	440	353
	Buying price/kg	642[1]	-	620	-	1,000	667
	Net revenue	-11,532	-	105,588	-	359,314	320,000
Factory agents	Investment	-	-	-	-	-	-
	Quantity (kg/month)	2,548	-	-	-	-	-
	Buying price/kg	1,963	-	-	-	-	-
	Net revenue	212,176	-	-	-	-	-
Bicycle traders	Investment	59,750	-	-	-	-	-
	Quantity (kg/month)	880	-	-	-	-	-
	Buying price/kg	1,400	-	-	-	-	-
	Net revenue	72,389	-	-	-	-	-
Boat traders	Investment	-	-	300,000	-	-	-
	Quantity (kg/month)	-	-	9,600	-	-	-
	Buying price/kg	-	-	1,300	-	-	-
	Net revenue	-	-	1,135,512	-	-	-
Pick-up traders	Investment	-	-	-	-	-	-
	Quantity (kg/month)	-	-	-	-	550	-
	Buying price/kg	-	-	-	-	500	-
	Net revenue	-	-	-	-	139,500	-

Notes: – = No data, * = Data not reliable. **1.** Investments considered: boats, boat engines, gillnets, smoking kilns and bicycles. Net revenue = Gross revenue - (Variable costs + Depreciation costs). The differences in fish quality and thus price were not realistically addressed when interviewing fishermen. The Buying price is easier to ascertain for most of the traders at landing sites. Selling price is hard to obtain due to the haggling tendencies of consumers and quality deteriorations. Source: FIRRI, 2002.

The level of investment in Nile tilapia production is lower, especially on Lake Victoria, implying low catches (Table 8) and low profitability. The fishermen on lake Victoria are concentrating so much on Nile perch whose price per kilogram is higher. This focus on one fish species, in situation of inadequate control of investments, has led to perch stock reduction with welfare implications to a range of actors in the fish sector. The Nile tilapia catch is better on Lake Kyoga than on Lake Albert, due mainly to larger tilapia stocks (Twongo, 2002). The larger harvested volume on Lake Kyoga implies higher profitability for pickup traders, who buy at a lower price (UShs 840 per kg) and sell Tilapia in urban centers, compared to traders buying fish from Lake Victoria (Table 8). Nile tilapia bicycle traders operating on landing sites on Lake Albert make higher profits than those on Lake Kyoga, due to less competition from other traders. Fish smokers on accessible sites on lake Albert are earning more due to the lower buying price (UShs 750 per kg) and better market access. Transport boat operators from the different islands obtain higher profit margins due to lower variable costs (Table 9). However, a further reduction in fish stocks is likely to reduce the amount of fish available, which is likely to increase the buying price and so the profitability may remain the same or increase depending on demand. The processors of export fish on average have a lower profit margin (Table 10). This may be attributed to their higher variable costs combined with the current shortage of raw materials.

Table 8. Profitability of *Nile tilapia* production, local processing and trading at selected landing sites on Lake Victoria, Kyoga and Albert (UShs) [1]

Category	Variable	Lake Victoria		Lake Kyoga		Lake Albert	
		Accessible	Non-accessible to fish trucks	Accessible	Non-accessible to fish trucks	Accessible	Non-accessible to fish trucks
Motorized fishing boats	Investment	-	*	-	*	-	-
	Catch	-	*	-	*	-	-
	Price	-	*	-	*	-	-
	Net revenue	-	*	-	*	-	-
Non-motorized fishing boats	Investment	140,664	*	821,088	*	555,175	309,911
	Catch (kg/month)	210	*	443	*	120	285
	Selling price/kg	700	*	733	*	475	800
	Net revenue	67,513	*	203,310	*	15,257	126,875
Fish smokers	Investment	-	*	-	*	43,100	26,833
	Quantity (kg/month)	-	*	-	*	500	204
	Buying price/kg	-	*	-	*	750	1,400
	Net revenue	-	*	-	*	780,000	192,000
Factory agents	Investment	-	*	-	*	-	-
	Quantity (kg/month)	-	*	-	*	-	-
	Buying price/kg	-	*	-	*	-	-
	Net revenue	-	*	-	*	-	-
Bicycle traders	Investment	-	*	80,000	*	-	-
	Quantity (kg/month)	-	*	160	*	1,200	-
	Buying price/kg	-	*	1,000	*	650	-
	Net revenue	-	*	138,875	*	1,280,000	-
Beach side traders	Investment	-	*	-	*	-	-
	Quantity (kg/month)	87	*	-	*	-	-
	Buying price/kg	500	*	-	*	-	-
	Net revenue	12,954	*	-	*	-	-
Pick-up traders	Investment	-	*	-	*	-	-
	Quantity (kg/month)	1300	*	35,104	*	-	-
	Buying price/kg	907	*	840	*	-	-
	Net revenue	37,988	*	1,545,400	*	-	-

Notes: – = No data, * = Data not reliable. **1.** Investments considered: boats, boat engines, gillnets, smoking kilns and bicycles. Net revenue = Gross revenue - (Variable costs + Depreciation costs). The differences in fish quality and thus price were not realistically addressed when interviewing fishermen. The buying price is easier to ascertain for most of the traders at landing sites. Selling price is hard to obtain due to the haggling tendencies of consumers and quality deteriorations. Source: FIRRI, 2002.

Table 9. Transport Boat Operators Costs And Margins (year 2002)

Category	'000 UShs per boat per year	UShs per kg fish	US$ per kg fish	% of total costs
Variable operating costs				
Raw materials	448,695	1,500	0.87	94
Sub-total variable costs	**448,695**	**1,500**	**0.87**	**94**
Fixed Operating costs				
Labor	8,190	27	0.02	2
Fuel and Oil	12,909	43	0.02	3
Repair and maintenance	500	2	0.00	0
License	500	2	0.00	0
Sub-total fixed costs	**22,099**	**74**	**0.04**	**5**
Capital costs	**3,125**	**10**	**0.01**	**1**
Total costs	**473,919**	**1,584**	**0.92**	**100**
Revenue	**533,962**	**1,785**	**1.03**	
Profit before tax	**60,043**	**201**	**0.12**	

Source: NRI and ITTA Transaction cost study (2002).

Table 10. Fish Processing Plants Costs And Margins (year 2002)

Category	'000 UShs per plant per year	UShs per kg of fish fillet	US$ per plant per annum	US$ per kg of fillet
Variable operating costs				
Raw materials	8,810,100	4,500	5,107,304	2.61
Packaging	506,581	259	293,670	0.15
Energy	360,000	184	208,696	0.11
Direct labor	289,315	148	167,719	0.09
Fuel	44,201	23	25,624	0.01
Sub-total variable costs	**10,010,196**	**5,113**	**5,803,012**	**2.96**
Fixed operating costs				
Management	276,000	141	160,000	0.08
Laboratory expenses	139,200	71	80,696	0.04
Administrative expenses	177,600	91	102,957	0.05
Fixed asset maintenance	67,200	34	38,957	0.02
Capital costs	549,600	281	318,609	0.16
Sub-total fixed costs	**1,232,400**	**629**	**714,435**	**0.36**
Sub total operating costs	11,242,596	5,742	6,517,447	3.33
Miscellaneous	416,291	212	240,865	0.12
Total operating costs	**11,636,087**	**5,943**	**6,745,558**	**3.45**
Annual revenue	**12,783,147**	**6,529**	**7,410,520**	**3.79**
Profit before tax	**1,147,060**	**586**	**664,962**	**0.34**

Source: NRI and IITA Transaction cost study (2002).

2.6 PUBLIC REGULATION AND SUPPORT

Several institutions are involved in the fisheries sub sector. They include: the Department of Fisheries Resources, DFR of the Ministry of Agriculture, Animal industry and Fisheries – MAAIF, Uganda Fish Processors and Exporters Association - UFPEA, Uganda Commercial Fish Farmers Association - UCFFA, Lake Victoria Fisheries Research Organization - LVFRO, Fisheries Resources Research Institute - FIRRI, and the Aquaculture Research and Development Center - ARDC, Kajjansi. UFPEA brings together fish processors and exporters and serves as their voice. UCFFA brings together commercial fish farmers and is involved in supporting and promoting commercial fish farming. FIRRI's mandate is to undertake, promote and streamline fisheries research in Uganda and ensure dissemination and application of research results. FIRRI's mandate areas include: Capture fisheries, fishing technology, fish production process, and post harvest processes. The ARDC, Kajjansi is under FIRRI and mandated to carry out research in aquaculture, aquatic environment health and dissemination of results. In this paper, particular emphasis is on DFR, LVFRO and ARDC, Kajjansi.

The overriding vision of the National Fisheries Policy, 2002 is the sustainable exploitation of the fishery resources at the highest possible levels for livelihood sustenance and income generation through exports (NFP, 2002). The policy has been described as a "detailed and well-structured document that provides clear overviews of the issues that inform policy statements, and is especially clear on assigning roles and responsibilities to different actors and institutions" (Allision, 2003). The government agency chiefly responsible for the implementation and administration of the policy is the Department of Fisheries Resources (DFR) of the Ministry of Agriculture, Animal Industry and Fisheries. DFR is also mandated to enforce a number of other policies, in particular the Fish (Quality Assurance) Rules of 1998, and to collect fish statistics.[x] Together the fisheries policies are meant to ensure that fish is caught using the right equipment, is of good quality all along the supply chain, and that production is sustainable. The fish quality assurance policy includes requirements for inspections and certification of landing sites, processing plants, and fish products (PSF, 2002). Between September 2001 and March 2003, funds were secured for the construction or

improvement of landing sites to improve the ability to comply with EU sanitary requirements, but the contracts were not awarded at the time of writing. DFR is also mandated to assess the quality of the environment where fish is caught.

The increase in demand for export quality fish, coupled with high domestic and regional demand, have led to widespread use of illegal beach seines and small gill nets (less than 5 inches) that catch immature fish. This has been cited as the cause of the fish stock reductions discussed earlier (Odongkara and Okaronon, 1997; Okaronon et al., 1999). The DFR's regulation unit has embarked on cracking down on the use of illegal monofilament nets, cast nets, and seine nets. A minimum size of harvestable Nile perch has been set at a length of 50 cm. Plans are also under way to close off breeding areas so as to allow fish stocks to regenerate. These regulations are meant to improve the size and age structure of Uganda's fish stock, particularly Nile perch. They will also increase the average value of fish, since older Nile perch fetch higher prices. However, the capacity of the DFR and the district fisheries authorities to effectively enforce them is hampered by inadequate resources. In order to improve and supplement the activities of the DFR, there are plans to set up a Fisheries Authority to take over some of its regulatory, monitoring and developmental functions.

Lake Victoria Fisheries Research Organisation (LVFRO) is a regional body in charge of harmonizing the use of resources among the three countries sharing the lake – Uganda, Tanzania and Kenya. LVFRO started its operations in July 1997 and is based in Jinja, Uganda. Its focus is the implementation of Fisheries Management Plans, but has had little impact on the ground so far, since fish regulations still differ substantially among the three countries sharing Lake Victoria. In this regard, the European Commission has recently approved a program worth 29.9 million Euros designed to assist Uganda, Kenya and Tanzania implement fisheries' management measures on Lake Victoria. The programme is to be implemented over a 5-year period (2003-2007) and focuses on the Fisheries Management Plans, which aim to maintain fish resources. Particular emphasis is placed on improving the capacities of government agencies, such as the DFR in Uganda, to monitor catches and enforce measures to thwart illegal fishing. This will be done mainly through training and provision of equipment and research vessels to monitor fish stocks.

2.7 LIVELIHOODS AND NUTRITION

The people living near the water bodies in Uganda have always depended on them for their livelihoods. It is estimated that about 250,000 people are involved in primary fish production and that 54% of these are on Lake Victoria (COMPETE, 2002). The reduction in fish stocks is likely to have adverse effects on the livelihoods of fishermen, traders, artisanal processors and processing factory workers. In the exploitation of a renewable resource like fish, the fisher folk/effort and the fish stocks have to reach equilibrium at a stock level where the revenue flow equals the cost (opportunity cost). The reduction in Ugandan fish stocks are likely to create situations where average costs are higher than revenues, which will force some exploiters out of fisheries (Pearce and Turner 1990), but we do not have data on the extent of this phenomenon. At the processing level, the industrial processors pay a higher price for Nile perch of export quality compared to what artisan processors and traders can pay. This has reduced the number of local Nile perch traders and processors and their level of income (FIRRI, 2002).

Fish in the great lakes region is a very important protein source and a solution to protein deficiency for children. However, there are concerns that the desire to maximize fish export revenues has superseded objectives of local food and nutrition security (Abila, 2000). The increase in production through the 1980s and early 1990s benefited local fish consumers in form of increased amounts of fish, especially Nile perch and Nile tilapia, at lower prices (Jansen, 1999). The increased demand for export quality fish in the 1990s has pushed up local prices and made such fish unaffordable to local consumers, causing them to switch to cheaper under-sized Nile perch, Tilapia and other fish species. From this perspective, DFR enforcement of the minimum fish size regulation may deny local consumers access to cheap Nile perch and Tilapia. Moreover, since regional trade in immature Nile perch was banned, there has been an increase in the industrial reprocessing of factory by-products and their export to regional markets that offer higher prices (FIRRI, 2003). This also reduces local access to cheap fish, raising a welfare question that must be addressed.

3.0 IDENTIFICATION OF ALTERNATIVE DEVELOPMENT STRATEGIES FOR UGANDA'S FISHERIES

In order to come up with alternative fisheries development strategies, the constraints affecting production, processing and trade; the opportunities in production and trade and the attempts at product diversification by the processors are explored in the sub-sections below.

3.1 CONSTRAINTS AFFECTING PRODUCTION, PROCESSING AND TRADE

The main factors leading to the current reduction in fish stocks are the high pressure on the fish stocks and the use of unauthorized gill net sizes and beach seines that catch undersized fish (Odongkara, 2001; FIRRI, 2002). For Nile perch, the reduction in prey abundance and a male biased population are other factors causing stock reduction (Twongo, 2002). Nile perch is a carnivorous species feeding on Uganda's two other main commercial species, Mukene and Nile tilapia. Fisheries management options have to take into consideration the competition for fish between Nile perch and the fishery. The lack of proper stock assessment data for the most productive lakes on which to base policy formulations and management decisions may limit the growth of the sector.

With the current reduction in stocks, fishermen have to move long distances for better catches, yet most of them use small, wooden and non-motorized boats. This suggests a need to improve boat productivity e.g. reducing the costs of production, while at the same time reducing the number of fishing boats (e.g. through the competitive sale of fishing licenses) to reduce competition over the limited fish resources.

Fish is a very perishable product that needs careful handling to maintain quality. Landing sites that handle fish must therefore meet the minimum sanitary requirements (clean water) and have proper handling (e.g. raised fish platforms) and cooling facilities. Most landing sites on Uganda's major lakes lack these requirements, resulting in large post-harvest losses of 15% – 30% in terms of export quality, but the low quality fish is consumed in local markets (PSF, 2002). The unsanitary conditions force processors to reject fish from such sites. Processors observe that the low quantity of fish procured from landing sites on Lake Albert is partly due to poor infrastructure rather than to the lack of

fish. Investments in roads and handling facilities at these sites are therefore important to reduce the over-dependence on Lake Victoria for fish of export quality, to increase producer prices in these areas, and to lower production costs so as to remain competitive even if prices drop.

3.2 PRODUCT DIVERSIFICATION BY INDUSTRIAL PROCESSORS

The current reduction in export quality fish is forcing processors to increase the net usable proportion of whole fish in an attempt to improve factory revenues. Fish skins are being exported to China. Fish by-products are increasingly processed into value added products like fish fingers, fish chips and sausages. These are mainly for local consumption with small quantities being exported. However, this may have welfare impacts especially on the poor who use fish frames/skeletons as food, and on the local processors who sell them. Diversification into higher value products, such as frozen, fish-based pre-cooked meals, may also be an option for the export sector, since 50% -- 60% of fish is exported as low value products (PSF, 2002), but no feasibility study has been done. Such a strategy would require better knowledge of consumer preferences, possibly through closer linkages to overseas buyers such as large retailers, aside investments in processing equipment and expertise. Relatedly, the fact that Nile perch is sold at the lower end of the market segment as a substitute for cod suggests potential for raising Ugandan export prices and revenues through product identification (i.e. creating awareness about the product) aside value addition.

3.3 FISH AQUACULTURE

Globally, aquaculture has contributed enormously to the growth in fish production. It represents currently 30% of global fish production and this figure is projected to increase to 41% by 2020 (Delgado et al., 2003). With most of the capture fisheries being over exploited, there are hopes that aquaculture may help reduce the pressure on natural fish resources. Aquaculture has been suggested as a viable option through which Uganda can increase fish production for the attractive export market as well as satisfy domestic and regional demand. Most aquaculture in Uganda is small-scale (Jagger and Pender 2001). The government of Uganda has set a goal of having 10% of fish exports come from aquaculture by 2006. In line with this, it supported the stocking of

20 dams with 3 million Tilapia fry between September 2001 and March 2003 (MFPED, 2003). The commercialization of fish farming is a key objective of Uganda Commercial Fish Farmers Association, an umbrella organization that brings together all fish farmers and encourages investments in fish farming.

Uganda has a favorable bio-physical environment for warm water fish aquaculture and it is estimated that over 70% of districts have potential for aquaculture development (FAO, 2002; Jagger and Pender, 2001). However, key production and marketing factors like; availability and quality of fish fry, availability of labor/cost of labor, access to inputs e.g. fish fry, availability of extension services, proximity to markets, proper roads and quality of the produce are likely to affect investments and profitability (Jagger and Pender, 2001). Fish farming is a labor intensive activity, involving pond construction and maintenance, feed collection, collection of manure, fertilization and protection of the ponds (Table 11). It is therefore mainly suited to areas with high population densities and low wage rates. The availability of extension staff to deliver technical knowledge hampers productivity. The new, farmer demand-driven, National Agricultural Advisory Services (NAADS) under the Plan for Modernisation of Agriculture offers a new opportunity for fish farmers to access to information on relevant technologies and marketing practices, but the service is still too new to gauge how much emphasis farmers place on aquaculture in their demand for services under NAADS, which covers a broad range of farm enterprises.

Table 11. Profitability of Aquaculture. Gross margin of a polyculture of African Catfish and Nile tilapia on a 3,200 m^2 pond

Polyculture of 9,600 Catfish + 6,400 Nile tilapia	**Values (UShs)**
Revenue	
Yield – Kg (after 8 months)	12,160
Unit price	1,500
Total revenue	*18,240,000*
Variable costs	
Pond construction (life span of 30 years)	102,250
Seed/fry	3,192,000
Organic feeds/fertilizers	48,000
Supplementary feeds	10,944,000
Labor – technical	2,000,000
Labor – unskilled	480,000
Total variable costs	*16,766,250*
Gross margin	**1,473,000**

Source: Department of Fisheries Resources, MAAIF, 2003.

3.3.1 Tilapia Aquaculture

Recent aquaculture research in Uganda has focused on Tilapia pond aquaculture. The reproductive biology, feeding and spawning habits of Tilapia are well known (Godfrey Mbhinzireki, personal communication, 2003). The Aquaculture Research and Development Center, Kajjansi has successfully combined Tilapia (surface feeder) and Catfish (bottom feeder) in pond aquaculture. It estimates that yields of 5 kg of Tilapia and 3 kg of Catfish per square meter per year are feasible. The very low growth rates (1 kg Tilapia and 3-4 kg of Catfish in about 30 months) under current farmer management (compare with Table 11) and stocking limit the incentives to invest in aquaculture. They are partly attributed to poor feeding techniques and overcrowding in fishponds. New sex reversal techniques developed at the Kajjansi Aquaculture Research Center will help reduce overcrowding, which is related to the fact that some Tilapia species start to reproduce already at about seven to nine months. Table 11 above shows the profitability of fish farming (a tilapia and catfish polyculture). Profitability could be increased with cheaper fry and reduced costs of feeding, especially regarding the supplementary feeds.

3.3.2 Nile perch aquaculture

Past research on Nile perch has focused on stock abundance, species distribution and general biology. Nile perch females mature at 90-100 cm in total length, compared to about 50-55 cm for males, and have a high reproductive potential (females produce 3-18 million eggs depending on size) with peak spawning during the rainy seasons (Table 12). Under natural conditions, harvesting can start after about 3 years. The high reproductive potential implies that restocking programs are potentially an effective way to restore wild fish stocks. Research at the Kajjansi Aquaculture Research Center is focusing on Nile perch spawning habits and feeding in captivity. Preliminary results show that the weight of Nile perch kept in concrete tanks and fed on Tilapia fry increases at a rate of 12% per week. However, successful domestication will involve switching feed from fish fry to cheaper pelleted feeds, since Nile perch is a heavy feeder. Support is required to develop such feeds for Nile perch. Additional research into optimal cage/pond stocking densities and the environmental impacts of artificial feeding in lakes is also required. Nile perch research is financed by foreign donors (especially DFID), and not by the government despite of the great economic importance of Nile perch. Nile perch aquaculture may have potential if the technical problems are solved, due to its faster growth and higher price than Tilapia and Catfish (Tuguniisirize Digo personal communication, 2003). It is therefore important that the government and the private sector get involved in the research on Nile perch aquaculture. There are three possible pathways following a (potential) successful breeding of Nile perch: restocking the lake using Nile perch fry, or rearing in fishponds or in net cages in the lake. Net cages could be a more cost effective means of Nile perch production since it does not occupy scarce land resources. Nile perch aquaculture, following successes in perch breeding will increase the quantity of export quality perch and the supply is likely to be more stable.

3.3.3 Comparing Tilapia and Nile perch aquaculture

Table 12 summarizes key aspects of Nile perch and Nile tilapia cage/pond farming. We note that there is a lack of information to allow for an adequate comparison of Tilapia and Nile perch aquaculture, especially regarding the economics of production.

Table 12. Characteristics Of Tilapia And Nile Perch Cage/Pond Farming

	Nile perch (*Lates niloticus*)	**Tilapia (*Oreochromis spp.*)**
Domestication and production	Not yet done, some research going on. Fisheries officials disagree on the extent of the pollution potentially caused by cage aquaculture in Lake Victoria.	Information on stocking densities, feed requirements and breeding conditions are available. Some commercial farmers in Uganda (using ponds not cages in open waters)
Reproduction potential	Female can lay 3-18 million eggs and mature at 90-100 cm total length.	*O. niloticus* female can lay 340-3,700 eggs. Other species lay 100-7,100 eggs
Time to harvest	In wild takes 3 years to be recruited into the fishery	*O. niloticus* takes about 2 years. Other species 9-12 month to attain table size

3.4 ALTERNATIVE DEVELOPMENT STRATEGIES FOR EVALUATION

Given the challenges and opportunities outlined above, we find that the fisheries industry in Uganda might potentially pursue four types of strategies to conserve fish resources, safeguard or enhance livelihoods, and maintain export earnings.

1. Decrease supply of wild catch Nile perch to sustainable levels and then keep it constant, through stock regulation.[xi]
2. Increase the supply of Nile perch of export quality through: (a) the introduction and promotion of cage/pond aquaculture or (b) Nile perch lake stock replenishment.
3. Increase supply of fish for domestic/regional markets through (a) pond aquaculture, and (b) stock replenishment.
4. Increase competitiveness of Ugandan supply chain: reduce the cost of production, transport, and processing; reduce post-harvest losses; improve product quality.

4.0 QUALITATIVE EVALUATION OF ALTERNATIVE DEVELOPMENT STRATEGIES

This chapter offers a qualitative, *ex ante* evaluation of each strategy with respect to market conditions, technical and institutional constraints and impact on incomes, poverty and the environment. The discussions are summarized in Table 13.

4.1 MARKET EVALUATION

Strategy 1 (decrease the wild catch of Nile perch to sustainable levels) will reduce the supply of wild catch Nile perch in the short run and significantly affect the quantity of perch available for international exports, as well as for domestic and regional consumption. From a market perspective, this implies that Uganda loses market share in the short term but avoid a total loss of its market position that would follow a depletion of Nile perch resources. For the domestic consumers, a reduction in Nile perch production will imply increased prices for perch and factory bi-products and consumers are thus likely to shift to other fish species or seek for alternative protein sources. That said, Nile perch is currently not widely consumed by poor consumers since the high export demand has increased its price compared to other fish species. Given the negative income effects of Strategy 1 (at least in the short term), it is appropriate to consider how it might be combined with (or trigger) other development strategies. Exporters may compensate for the reduced access to wild catch of Nile perch in at least two ways. First they may diversify exports to include fillets of Nile tilapia or Catfish, which to a large extent would have to be produced through aquaculture on their own or others' fish farms. This production may also target regional and domestic markets (Strategy 3). In the longer term they may start production of Nile perch through cage or pond aquaculture if the required technologies are developed (Strategy 2). A second option is to engage in value-added production such as precooked meals, although this would require new investments in processing equipment as well as new market linkages (Strategy 4).

Regarding Strategy 2 (increase the supply of Nile perch through cage/pond aquaculture and lake stock replenishment after successful breeding), the current high demand for Nile perch in the export market, combined with the diminishing wild stocks,

is a good argument for investing in the development of technology to breed Nile perch in captivity. This would help increase or maintain the supply of export quality Nile perch thus improving or safeguarding Uganda's position in the EU and other markets for high-value fish. In this respect, Uganda may soon face competition from farmed Nile perch from countries such as Egypt and China that are said to be in advanced stages of perch breeding.[xii]

Increasing fish production for the domestic and regional markets through aquaculture or stock replenishment (Strategy 3) seems sound from a market perspective, given the high projected growth in fish demand and the low entry barriers in these markets. Increased supply will also reduce the upward pressure on local fish prices caused by the growth in fish exports and the depletion of wild fish stocks, to the benefit of consumers. Nile tilapia, Catfish and 'Ningu' are the best species for domestic and regional markets, while few local consumers would be able to afford Nile perch, whose price is determined by market conditions in high income countries. The former species were also the most commonly consumed species until Nile perch established itself fully in Uganda's lakes. According to Jagger and Pender (2001), the greatest potential for small-scale aquaculturalists will be the sale of fresh good quality fish in the urban and peri-urban markets of Kampala and Jinja, where the demand for fish is highest and the supplies from catch fisheries may be decreasing. Peri-urban areas in general will also have the best marketing infrastructure, more traders, and the highest volume traded, which would tend to increase fish farm gate prices and net returns (Ibid).

With respect to Strategy 4 (improve productivity, marketing and quality), most stages in Uganda's fish supply chain – from production to the final point of export – suffer from significant inefficiencies. The high variable costs related to production (motorized boats) and other fishing equipment reduces net revenues in the current situation of reduced fish stocks and competition from other fishermen who have also increased their fishing capacity. Many landing sites lack proper handling facilities e.g. weighing shades, clean water, causing high post-harvest losses and, in turn, a reduced quantity of fish in the market. The quantities of ice used to preserve fish are low (a fish to ice ratio of 3-5:1) to enable full preservation. Poor roads make some sites inaccessible, especially during the rainy season, while the related high transportation costs reduce the

buying price at accessible sites. An improvement in the technology used in production, transportation, handling, and processing, coupled with better infrastructure, would thus be required to increase the quality and quantity of Ugandan fish products.

4.2 TECHNICAL EVALUATION

Decreasing the supply of wild catch Nile perch to sustainable levels and then keeping it constant, through stock regulation (Strategy 1) is seriously constrained by lack of personnel and equipment needed to collect reliable fish stock data and identify maximum sustainable yield levels. The last stock assessment in Lake Victoria was done in 1997 (and even these data are not very convincing), but stock levels are likely to have changed significantly since then, as earlier discussed. No stock assessment data exist for Uganda's other major lakes (Albert, Kyoga, George, Edward, and Wamala). Stock assessment data are thus merely estimates by the Department of Fisheries Resources and district fisheries staff, whose accuracy is impossible to assess. Fish stock regulation through minimum size enforcement is ineffective due to lack of equipment like patrol boats to monitor the activities of fishermen on the major lakes.

There are still serious technical problems related to breeding Nile perch in captivity (Strategy 2), particularly regarding stocking levels, feeding techniques, and environmental impact. Work on breeding is in its infancy and raising female perch in captivity up to reproductive size/age may be quite difficult, since perch is carnivorous. Successful domestication must involve a change in feeding habits that may take some time, since it is uneconomical to feed it on Tilapia fry. The Nile perch's big appetite raises questions regarding potential pollution from feed if it is farmed in cages in the lakes.

On Strategy 3, the technology for Tilapia and Catfish production has already been developed. Few components of the technologies developed in Catfish and Tilapia fishpond aquaculture at the research stations, such as low-cost feeding techniques, have been adopted by fish farmers, suggesting the need for enhanced public investments in extension advice on proper fishpond/cage construction and management (Edward Nsubuga, personal communication, 2003). Investments should focus on areas with high population density and low wage rates, which can provide both the market for fish and

labor, since aquaculture production is quite labor intensive. There is also a shortage of fish fry production centers in Uganda, which is seriously hindering the growth of aquaculture. There are attempts by the Aquaculture Center to rejuvenate the old and set up new fry production centers in the high potential areas.

Diminishing fish stocks (catch per boat) increases the pressure for technological advancement especially in production, handling and processing (Strategy 4). In this regard, the Fisheries Resources Research Institute (FIRRI) is developing more cost efficient boats that would reduce the variable costs of production. Such technology development efforts must involve the fishermen and the boat makers at the landing sites to enhance the likelihood of adoption. The deficient handling and transportation facilities are responsible for high post-harvest losses that increase the average cost of marketed fish. Facilities like jetties, cold chains, and clean water are lacking at most landing sites. Efforts to raise the quality and quantity, and reduce costs of export fish have to focus at this stage. There is also scope for technical improvements at the processing level, especially regarding the production of value added products. The latter will involve new equipment, skills, as well as market studies, but may be a feasible and logical next step in the development of the processing industry.

4.3 INSTITUTIONAL EVALUATION

More effective regulation is clearly needed to protect the industry from depleting its fish resources (Strategy 1). Such regulation should include much stricter measures that control the number of fishing boats as well as the number and size of gill nets used by boats. Such controls exist on Lake Edward and Lake George and are enforced, but not on the large lakes Victoria, Albert and Kyoga.

Lack of human and financial resources seriously hampers the capacity of the most important regulatory body, the Department of Fisheries Resources (DFR), to accomplish its mandate. The fisheries data are unreliable. The Department is unable to fully monitor the activities of fishermen on the lakes and so to control the catch of under-size fish and other illegal activities. At the processing level, DFR has not enforced the quota system that was designed to regulate the quantity of fish for processing and export. The processing plants have thus increased their capacity despite the shortage of raw materials,

with the effect of lowering the returns to investments. The Lake Victoria Fisheries Research Organisation (LVFRO) was created to guarantee harmonized actions in managing Lake Victoria resources, but it has had a small impact on the fisheries sector in Uganda since its inception in 1997. Strategy 1 thus depends on a significant improvement in the capacity of the development and regulatory agencies within the fisheries sector, particularly DFR and LVFO. With the establishment of a Uganda Fisheries Authority and EU program support to national Fisheries Management Plans for Lake Victoria, Strategy 1 seems more feasible but stock assessment is still necessary.

Aquaculture is the main source of growth in global fish production, and Uganda has potential to increase fish production in this way also, as suggested by Development Strategies 2 and 3. While official government policy supports aquaculture due to its potential contribution to national income and fish farmer welfare, few public resources have actually been committed to this cause e.g. research, extension despite the large contribution of fisheries sector to national income. Government institutions involved in aquaculture development, notably the DFR's Aquaculture Unit and the Kajjansi Aquaculture Center, are poorly funded and this has crippled their research and development activities. Better government funding of research, development and dissemination to fish farmers thus appear important to realize Uganda's potential for aquaculture.

Private organizations in the fisheries sector can help improve fish production, handling and quality. The Fish processors and exporters are already organized but the fishermen are not. The organization of fishermen offers an opportunity for them to demand a higher price for quality perch on the market.

4.4 EVALUATION OF LIKELY INCOME AND POVERTY IMPACTS

Improving access to fish and fish based income by the poor requires a combination of stock regulation, increased production through aquaculture, and the lowering of production costs. Strategy 1 (decrease the wild catch of Nile perch to sustainable levels) will reduce the supply of wild catch Nile perch in the short run and significantly affect the quantity of perch available for export, and local and regional consumption. This will obviously reduce the earnings and profitability of exporting

processing plants, traders, transporters and fishermen. Yet because the current level of exploitation is likely to be above the maximum sustainable yield, particularly when considering the large harvests of under-size fish, it seems necessary to forego some income in the short term in order to protect the resource base of the industry in the long term. Artisan processors are likely to suffer an additional income loss, because a higher share of the fish landed will have the size required for export. We discuss below the possible income effects of changes in fish supply associated with Strategy 1, 2 and 3, but note here that a more reliable estimation of these effects requires quantitative modeling using information on price and income elasticities, among other data.

An increase in the supply of export quality Nile perch through the introduction and promotion of cage/pond aquaculture or Nile perch lake stock replenishment (Strategy 2) will have both positive and negative effects on incomes. Increased supply of Nile perch through aquaculture will increase factory revenues and employment but may reduce the income of fishermen, since increased output from aquaculture will tend to reduce the price paid by exporters for wild Nile perch, assuming full substitutability between aquaculture and capture fish. Lake stock replenishment will improve the catch of fishermen due the recovery of the fish stocks, and possibly also their incomes unless reduced prices caused by increased supply totally offset the income effects of increased catch. Nile perch aquaculture will tend to reduce prices through increased supply thus affecting fishermen incomes negatively. It may also increase the access to fish (factory rejects and by products) by the poor, and local traders will increase their revenues.

Increasing the supply of fish for domestic and regional markets through pond aquaculture and stock replenishment (Strategy 3) will impact many actors in the sector as well as local consumers. Regional export revenues will increase, as will the incomes of fishermen and fish farmers but this will largely depend on the elasticity of demand. Consumers will improve their access to cheaper fish, particularly Nile tilapia and Catfish, which will in particular benefit the poor. This development strategy thus holds promise of many and significant economic benefits, especially to the local population. It will also benefit national fish protein nutrition security, which seems to have suffered over the last 15 years from the dramatic increase in fish exports.

Increased competitiveness of Uganda's fish supply chain (Strategy 4) may offer opportunities to augment the incomes of some participants in the supply chain through cost reductions, and possibly also improve poor people's access to fish through lower prices. Increased competitiveness, e.g. through infrastructure improvements, would also lead to the exit of the less efficient actors (already observed in some places among traders and processors), and reduce the enormous profits made by traders operating in the relatively inaccessible sites. These issues were discussed above. Infrastructure improvement in Lake Kyoga and Albert will augment the amount of fish procured by processing plants and in turn fish exports, but would at the same time reduce the fish available to artisan traders and processors, as seen on the big landing sites on Lake Victoria (e.g. Kasenyi, Katosi and Dimmo).

4.5 EVALUATION OF LIKELY ENVIRONMENTAL IMPACTS

Much has been said and written about the reduction in species richness following the introduction of Nile perch into Uganda's major lakes in the late 1950s and early 1960s (TED case study, undated; Twongo, 2002; Okaronon et al., 1999). Many of the endemic species and especially the haplochromines that evolved under the special conditions offered by Lake Victoria have been lost to the carnivorous Nile perch, and several more are threatened. This has in turn reduced the feed resources available to the Nile perch, contributing to its reduced size. There are also reports that larger perch are feeding on smaller ones (cannibalism).

Strategy 1 and 2b (fish stock regulation and Nile perch lake replenishment) would definitely increase the predatory pressure of Nile perch on other species. It is therefore important that Nile perch restocking is combined with the monitoring, and perhaps replenishment, of the stocks of fish fed on by Nile perch (Haplochromines, Mormyrids, Tilapias, Catfish, Carps, Bagrus, and Labeo). The size of the predatory impact is difficult to predict given the paucity of data on the stocks, reproductive biology, and resilience potential of these species.

A mix of strategies appears necessary to improve or maintain the biodiversity of the lake and at the same time improve fishery revenues, e.g. a combination of Strategy 1, 2, and 3b (lake stock replenishment of non-perch species). The Department of Fisheries

Resources is planning to create protected breeding areas so as to rejuvenate fish stocks. Nile perch and Nile tilapia cage aquaculture is still a contentious issue among fisheries officials due to the risk of polluting the lakes. This aspect requires further research. Given such uncertainty, it appears more environmentally sound to focus on (land-based) fishpond aquaculture.

Strategies (2a and 3a) involving pond aquaculture will lead to land use changes, often in wetlands where the opportunity cost of land is lower than in upland areas suited for crop farming (Jagger and Pender 2001). Small-scale fish farming is actively promoted by the government as a sustainable use of wetlands to help protect these from more destructive uses such as brick making and draining for agriculture (Ibid). Yet if not carefully managed, fish farming activities may also alter important ecosystem functions of wetlands, such as water purification and water supply, and cause chemicals or pesticide residues on fish feed to enter the natural environment (Ibid). However, at a small scale and under appropriate management, wetlands may be used for aquaculture and serve to perform required ecosystem functions at the same time. Strategy 4 (reduce the cost of production, transport, and processing; reduce post-harvest losses; improve product quality) is likely to have mainly positive environmental impacts through a more efficient use of natural and other resources.

Table 13. Summary of Evaluation of Alternative Development Strategies for Ugandan Fisheries

Development Strategy	Evaluation Criteria				
	Market conditions	**Technical constraints**	**Institutional constraints**	**Income and poverty impacts**	**Environmental impact**
1. Decrease supply of wild catch Nile perch to sustainable levels and then keep it constant, through stock regulation	* Less fish for sale; possible loss in export revenue in short run. * More income with stock rejuvenation * Species diversification e.g. tilapia, catfish	*Inadequate resources (monitoring boats & personnel) and technology to reliably assess fish stocks for effective regulation.	* The Department of Fisheries Resources and the district fisheries staff lack the capacity and resources to enforce the regulations * More resources and personnel	*Fishermen incomes may increase in the long run due to sale of bigger fish. * Locals will be deprived of fish as a source of protein in the short run	* Minimum size regulation may increase the predatory pressure of Nile perch (carnivorous) on other species
2. Increase the supply of Nile perch of export quality through aquaculture or replenishment of the lake stock	* There is a ready export market for high quality Nile perch, more revenue * Stock replenishments may increase perch supply in local/regional markets.	* Lack of technology to breed Nile perch in captivity * Poor knowledge of Nile perch feeding habits * Domestication must change perch eating habits.	* The Aquaculture Research Center (Kajjansi) is poorly funded. Most research is donor funded and few funds come from the government. * More resources and personnel	* The expected increase in the fish stocks will increase catches and so incomes of fishermen. * May increase poor peoples' access to low quality fish (rejects) and factory by-products (fish skeletons).	* Increased stock of Nile perch will increase the predatory pressure on other fish species.
3. Increase supply of fish for domestic and regional markets through pond aquaculture and stock replenishment	* Supply fish to domestic and regional markets. * increased supply may reduce fish prices	* Technology already available for breeding Tilapia and Catfish * More research on cage aquaculture is needed	* Inadequate fry production facilities * Lack of resources e.g. extension staff to adequately promote aquaculture.	* Incomes of fish farmers and fishermen will increase * Improvement in poor people's access to fish protein	* Fish pond development will change land use in especially wetlands, with possible negative impact on biodiversity and ecosystem functions
4. Increase competitiveness of Uganda's fisheries: reduce production, transport, handling, and processing costs; reduce post-harvest losses; improve product quality	* Market available for the better quality products * This may require a reduction in production costs, better fish handling and infrastructure	* Available technology still poor (handling and processing) * The use of ice at lower ratios to fish e.g. 1:1 can reduce post harvest losses	* Institutions exist (DFR, UFPEA) but lack the capacity and will to cause changes is still lacking	* More income from fish * Increased profitability at the primary production level. * Will improve regional access to factory processed fish.	* Improved technology in especially processing is likely to reduce waste generation.

5.0 IMPLICATIONS FOR POLICY AND PROGRAM DESIGN

5.1 POLICY IMPLICATIONS

Below we tentatively discuss some policy implications (and related program investment priorities) of the analyses presented in the previous sections. We treat one strategy at a time, but refrain from recommending one over the other due to the limited scope of the study. That said, our sense is that a combination of strategies with emphasis on Strategies 1 and 3 would be the most likely outcome of a more in-depth and quantitative evaluation. Such additional research effort would also help identify the set of policies and program investments that would be most effective for implementing each strategy.

Strategy 1 – All fish production, investment and development decisions warrant proper base data/information on fish stocks, fish species reproductive biology and their resilience potential. Most of this information is either inadequate or lacking. The capacities (personnel, equipment and research funding) of the Department of Fisheries Resources and of the Fisheries Resources Research Institute have to be improved. The shift should be towards an effectively controlled fishery (effort level, quantity, and size of the fishing gear) like in most developed countries, though it may require extra effort and time. Fishermen are important stakeholders and all efforts must be geared towards ensuring their full participation in the management of the fisheries.

Strategy 2 – Nile perch breeding in captivity for either pond/lake aquaculture or lake stock replenishment offers potential for increased revenue. There is need for support to research and development of Nile perch breeding and feeding technologies, although the technical difficulties involved are likely to be considerable and to take several years to overcome.

Strategy 3 – This strategy (increasing fish supply in local and regional markets through aquaculture or lake stock replenishment of Tilapia, Catfish, Labeo) is likely to have a large impact on local/regional fish supply, and on the incomes of fish farmers and traders, or fishermen in the case of lake stock replenishment. It is imperative that aquaculture technologies are more effectively disseminated. This strategy includes rejuvenating existing, dormant or under-productive fish farms and constructing new ones.

Strategy 4 – Efforts should be directed at reducing post-harvest losses through improved handling and better icing (manufactured from clean water and at higher ratios to fish than presently practiced e.g. a ratio of fish to ice of 1:1 is good for preservation). In addition, there is a need to improve the access roads to many landing sites. This will reduce marketing costs, improve the stability of fish supply to export processing factories and local markets, reduce post-harvest losses of export quality fish, and improve the quality (freshness) of locally consumed fish.

5.2 AREAS FOR FURTHER RESEARCH

This study has identified a need for more analyses that would inform the choice of strategies and associated balance of public investments, including: (a) quantitative estimates of the costs and benefits associated with each strategy or components of strategies; and (b) separate analyses for each major lake, which may warrant different strategies and investments. These and the analyses suggested below would to a considerable extent require the collection of primary data through surveys or case studies, since data quality and availability on Ugandan fisheries is particularly lacking. Specific areas for further research are summarized here:

- Rigorous and more frequent assessments of fish stocks in the major lakes are required in order to assess the MSY. In addition, there is a need for better information on the reproductive biology and resilience potential of species preyed on by Nile perch.
- Research into the political, legal, and economic aspects of the competition over fisheries resources among the countries sharing Lake Victoria promises to greatly enable regional regulation efforts.
- It is important to ascertain the overall impact of the current reduction in fish stocks on fishermen livelihoods. Allison (2003) offers some insights in the case of Lake Kyoga.
- Smallholder pond aquaculture was booming in the 1960's and 1970's, but has not recovered from the devastating effects of civil strife despite favorable markets. It is therefore important to examine the factors that currently constrain or enable aquaculture production in Uganda, in order to guide program designers and potential investors in aquaculture (see Jagger and Pender 2001).

- Cage aquaculture in the lakes is a contentious issue, especially regarding the possible polluting effect of fish feed. This area requires more research.

6.0 CONCLUSION

In this study we have formulated and evaluated alternative development strategies for the Ugandan fisheries, focusing on Nile perch, based on a review of the current situation, which is characterized by declining fish stocks (we assume based on incomplete evidence) and reduced profitability throughout the sector. Our assessment has been qualitative in nature and moderate in scope, and has pointed to areas where more in-depth and quantitative analyses are needed to better inform the choice of (a mix of) strategies and associated (balance of) public investments. These analyses would require the collection of primary data through surveys or case studies, due to the poor quality and availability of data on the sector.

Strategy 1 – decrease the wild catch of Nile perch to sustainable levels through improved stock regulation – is likely to lead to the recuperation of fish stocks and thus increased revenue in the long run, although at the cost of reduced income in the short term. Its implementation will require increased, joint efforts by the Department of Fisheries Resources and the Lake Victoria Fisheries Research Organisation in national and regional regulation, requiring more resources (personnel, funds, equipment) and collection of better data on fish stocks, effort level, fish reproductive biology and resilience potential. *Strategy 2* – Nile perch breeding in captivity for either pond/lake aquaculture or lake stock replenishment – is likely to increase the supply of export quality fish, generating more revenue and increasing the access to fish by the poor. This strategy requires investments in developing Nile perch breeding technology in captivity and in research on the environmental impact of lake cage aquaculture.

Strategy 3 – aquaculture or lake stock replenishment of Tilapia, Catfish, and Labeo – is likely to impact heavily on the supply of fish in local and regional markets, improve access to fish protein by the poor, and higher incomes to fish farmers or fishermen. While technologies are already available for breeding and farming Tilapia and Catfish, expansion of this aquaculture is constrained by low extension efforts and

inadequate fry (feed) production. *Strategy 4* – enhanced productivity and quality and reduced post-harvest losses – will increase the quality and quantity of fish as well as incomes, but its implementation would require considerable investments in infrastructure and new technologies. Increasing the efficiency of the supply chain for fish of export quality may reduce the quantity of fish available to local traders and processors.

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ANNEX 1: DATA SOURCES

Fish production and consumption data was obtained from the Department of Fisheries (FDR), Ministry of Agriculture Animal Industry and Fisheries (MAAIF). Data on fish exports was obtained from Uganda Fish Processors and Exporters Association, UFPEA (records and interview with the chairperson) and three randomly selected fish processors/exporters (Uganda Marine Products Ltd, Uganda Fish Packers Ltd and Ngege Ltd). Data on profitability were obtained from surveys conducted in 2002 by the Fisheries Resources Research Institute (Socio-economic section) on Lake Victoria, Kyoga and Albert. For Lake Victoria, data for three landing sites (Dimmo, Kasenyi and Bwondha) accessible to fish trucks was aggregated to obtain profitability of fish production, processing and trade. Data for Kansiira (accessible) and Iremeria (inaccessible) landing sites on Lake Kyoga was used. For Lake Albert, data was obtained for Kabolwa (accessible) and Somsio (inaccessible) landing sites. The FIRRI surveys used stratified random sampling to select the landing sites but the respondents were selected on availability/willingness basis. For some categories like the local processors, the number of respondents at some landing sites was low. The selection of sites on the northern side of Lake Kyoga was hampered by LRA rebel activity in the area. Some sites on Lake Albert were left out of the sampling frame due to poor accessibility (western rift valley). Other profitability data were obtained from the IITA/NRI survey report.

ANNEX 2: PERSONS INTERVIEWED

Mr. Nugawela Patrick – Business Development Services Advisor, SPEED Project.

Mr. Tilia David – Senior Fisheries Officer, DFR

Mr. Okaronon Obbo John – Senior Research Officer, FIRRI

Dr. Odongkara Constantine – Senior Socio-economist, FIRRI

Dr. Mbhinzireki Godfrey – Officer in Charge, Kajjansi Aquaculture Research and Development Centre.

Mr. Owor Wadunde – Senior Research Officer, Kajjansi Aquaculture Research and Development Centre.

Mr. Nadiope Eric – Senior Fisheries Inspector in Charge of Regulation, DFR

Mr. Wadanya – Officer in charge statistics unit, DFR

Mr. Johny, P.K – Production Manager, Ngege Ltd

Mrs. Amongin Matilda – Quality Assurance Manager, Ngege Ltd

Mr. Sridhar Annappa – Production Manager – Uganda Fish Packers Ltd.

Mr. Yogesh Grover – Managing Director – Uganda Marine products. Chairman of Uganda Fish Processors and Exporters Association (UFPEA).

Mr. Nsubuga Edward – commercial fish farmer and Chairman of Uganda Commercial Fish Farmers association (UCFFA)

Mr. Tuguniisirize Digo – commercial fish farmer

ANNEX 3: INDUSTRIAL FISH PROCESSORS CHECK LIST

Strategic Criteria for Rural investments in Productivity (SCRIP)
International Food Policy Research Institute, Kampala, Uganda

Welfare Evaluation of alternative Development strategies and Intervention options for Uganda's Fisheries sector with emphasis on the Nile perch export sub-sector

Industrial processors checklist

A. Background information

1. Name of the respondent
2. Date of interview
3. Age
4. Sex
5. Position held
6. Nationality/Ethnicity

B. Level of investment and profitability

1. Investments so far (structures, processing technology, fish transportation etc).
2. Capacity of the processing plant/installed capacity per year
3. Technology used in processing
4. Quantity of fish received per month/year and the species
5. Fish products that are being exported.
6. Buying prices – per Kilogram of the major fish species i.e. Nile perch and Tilapia at landing sites and how they are set.
7. Export prices (frozen fish, chilled fillets, fish skins etc)
8. Market at the international level - demand/major importers of Ugandan fish and the emerging markets.
9. Incomes to processors/exporters. Any changes with reducing raw materials (fish) availability.
10. Incomes to factory workers.
11. Export products and fish type diversification.
12. Local/regional demand for factory bi-products/fish skeletons.

C. Research and Development

1. Potential for Nile perch cage aquaculture
2. Potential for aquaculture to cover the demand gap
3. Investments in fish farming/cage aquaculture

D. Problems and challenges at this level

ANNEX 4: PUBLIC ORGANISATIONS CHECK LIST

Public organizations (Fisheries and Fisheries Research Departments) checklist

A. Background information

1. Name of the respondent
2. Date of interview
3. Age
4. Sex
5. Position held
6. Nationality/Ethnicity

B. Fish stocks and Catch data

1. Fish stocks in the main lakes – Victoria, Albert and Kyoga (major fish species i.e. Nile perch, Tilapia and African catfish).
2. Seasonality in production
3. Technology used in exploitation.
4. Catch from the major lakes of each fish type.

C. Consumption (Local, regional and international)

1. Quantity of Nile perch, tilapia, catfish and other fish species consumed locally and the value
2. Quantity exported and the value (regional and international

D. Regulation

1. Minimum /Legal fish sizes and gillnets (for Tilapia and Nile perch).
2. Old and upcoming/new regulations
3. Regional regulation (fishing and trade).
4. Attempts at harmonizing Lake Victoria management in the three countries.

E. Research and Development

1. Any attempts at breeding Nile perch in captivity
2. Growth rate of Nile perch and trials of cage aquaculture
3. Potential for increased catfish/tilapia production through aquaculture
4. Possible forecasts of fish consumption (National and regional)
5. Research attempts at species diversification e.g. Catfish for the export market and regional consumption.

ENDNOTES

[i] The fatty acids and the bone free white flesh are two factors leading to its demand. Most fish species have these essential fatty acids but the extent differs. For Nile perch, the above factors combine well.
[ii] The maximum sustainable yield for Uganda's shares of Lakes Victoria, Albert, and Kyoga has been estimated at 300,000 tons by the government of Uganda (NFP 2002). This figure is not supported by any systematic or rigorous stock assessment, however. A change in species composition has occurred over a longer time period.
[iii] There has already been a noticeable decline in bicycle traders and local processors, especially on some landing sites accessed by factory trucks (FIRRI, 2002), and processing plants are operating at well below capacity.
[iv] According to the national household surveys (UBOS, 2003), there was a 12.5% nominal increase in consumption per capita between 1999/2000 and 2002/03. According to the 2002/03 National Household Survey, the monthly nominal mean consumption expenditure per capita was Ugshs 23,474 for rural households and Ugshs 70,167 for urban households.
[v] The sharing of water bodies, efforts applied elsewhere, the catch and the associated implications are not discussed in this report.
[vi] Open access in the sense that any national with a boat and gillnets can do fishing.
[vii] Global fish production is projected to increase with 37 million metric tons between 1997 and 2020, while capture fisheries in sub-Saharan Africa is estimated to grow by two percent per year in the same period (Delgado et al., 2003).
[viii] The data presented in Table 4 and Table 5 correspond with those presented by Odongkara (2001), which reveal a reduction in catches and fish revenues at the primary production level. Unreliable data were left out.
[ix] Net revenue = (Gross revenue) - (Variable costs + Depreciation costs). This also applies to data presented in Table 8.
[x] Earlier legislation on fisheries includes the Trout Protection Act (1936), the Fish and Crocodile Act (1951), the Ordinance Act (1958), and the Fish and Crocodiles Act (1967).
[xi] We assume here, admittedly based on incomplete evidence discussed in Sections 1.2 and 2.3, that current fishing methods and off-take rates are unsustainable.
[xii] Faced with such threats, Uganda, Tanzania and Kenya are planning to patent Nile perch from Lake Victoria as 'Victoria Perch'.