FARMING FISH FOR PROFITS: A STEP TOWARDS FOOD SECURITY IN SUB-SAHARAN AFRICA

Nathanael Hishamunda, Ph.D
Department of Fisheries
Food and Agriculture Organization
of the United Nations(FAO),
Rome,
Italy

Neil B.Ridler, Ph.D, .
Centre for Coastal Studies and Aquaculture,
University of New Brunswick,
Post Office Box 5050 Saint John,
New Brunswick,
Canada E2L 4L5
Ridler@unb.ca

This study is part of a larger project on promoting commercial aquaculture in sub-Saharan Africa funded by the Food and Agriculture Organization (FAO) of the United Nations. The authors would like to express their appreciation to staff of the FAO who provided comments on the report and in particular to Ulf Wijkstrom and the core team of the project. All opinions expressed in the paper are the sole responsibility of the authors and do not necessarily reflect those of the FAO.

ABSTRACT

Aquaculture is the world's fastest growing source of food with 90 per cent of world tonnage coming from developing countries. For those countries it is a source of food security; through the generation of economic growth and therefore enhanced food accessibility, through increased availability either directly from domestic production or from foreign exchange earnings, and also perhaps greater food stability. While in Asia (China in particular), and Latin America there has been a dramatic expansion in aquaculture output, aquaculture has grown much slower in sub-Saharan Africa. Currently the region accounts for less than one percent of world output. This paper suggests some policy options for the promotion of private investment in the sector. Emphasis is on polices that incur few government expenditures.

According to the latest FAO statistics, approximately 800 million people in the developing world

are food insecure, a quarter of them in sub-Sahara Africa (FAOa, 2003). However while the number of food insecure people globally is expected to decline, sub-Sahara Africa (SSA) is forecast to experience an increase. Part of the cause (if not the principal cause) is the absence of economic growth among the region as a whole. Average real per capita incomes in SSA are lower now than thirty years ago, so fewer people are able to access food, even if it is available.

In the 1960s and 1970s the focus on food policy was on self sufficiency and food availability, but since the 1980s food demand has become a priority and with it ensuring economic access to food (Maxwell and Slater, 2003). Thus the southern African Region's strategy paper on food security argued for an approach that concentrated on improved income streams so that households can access food; policies to alleviate poverty should be combined with measures to increase food availability. (Duncan 1999). Increasingly the private sector with its investment was seen as key to poverty alleviation and therefore food insecurity. The emphasis on the private sector and its entrepreneurship and investment conforms to the more recent NEPAD commitment.

This paper examines the private sector and aquaculture in SSA. The focus is on aquaculture that is termed "commercial" because it is entrepreneurial and profit oriented (Hishamunda and Ridler, 2003). While such farms are a minority in SSA, where most aquaculture is artisanal, they have the advantage of requiring little government or donor assistance, which is important in the context of SSA (Machena and Moehl, 2001).

Aquaculture is the world's fastest growing source of food, outpacing terrestrial meat production. Its output is food; it also creates employment income that can be used for purchasing food. Hence even if the product is not consumed on the farm, commercial aquaculture pays wages and earns profits that contribute to food security. It is also a sector likely to expand, both in absolute tonnage and relative to the commercial fisheries. Aquaculture's present and growing importance therefore merits study, particularly as most aquaculture (82% of world tonnage in 2001) occurs in Low Income Food Deficit Countries.

The paper does not provide the link between aquaculture and food security which has been done elsewhere (Ahmed and Lorica, 2002). Instead its focus is the development, or absence, of

aquaculture in SSA. A further section suggests policies that could promote commercial aquaculture. Private investors in Africa cite political and policy instability, openness to trade, and governance as the principal deterrents to investment in the region (World Economic Forum, 2000). By providing an environment conducive for investment, enabling policies, such a guaranteed property rights, reassure risk-takers. In addition to enabling policies there are policies specific to aquaculture. Because of fiscal constraints facing governments in sub-Saharan Africa, this paper will suggest two policies that do not require large outlays.

1. THE EVOLUTION OF AQUACULTURE IN SUB-SAHARAN AFRICA

From 2.6 million tons in 1970 world aquaculture output (excluding aquatic plants) grew to 38 million by 2001. This is an annual average growth rate of more than 9 per cent, and a faster rate than other animal food producing systems such as the capture fisheries and terrestrial farmed meat (FAO, 2003b). Aquaculture's share of world food fish supply has grown from 7.0 percent of world tonnage in 1973, to 12 percent in 1985 and to more than 30 percent in 2000. With much of the fisheries at or near their limit, aquaculture's contribution to food fish supply will increase. In 2020 baseline forecasts suggest that aquaculture will account for 40 percent of food fish supply by 2020, but it could be higher and exceed 50 per cent (Delgado et. al., 2003).

Much of this aquaculture expansion has occurred in developing countries particularly China. From 28 per cent of world aquaculture output in the 1980s, China's share rose to than two-thirds of world output by 2000. However other Asian countries and some Latin American countries have also seen impressive output gains. Developing countries other than China have seen their share of world output (excluding China's contribution) climb from 50 percent in 1980 to 69 percent in 2001.

Yet SSA is a region that has not shared this rapid expansion. Using three year averages as end points, annual average growth rates in aquaculture output (excluding aquatic plants) from SSA averaged 8.8 percent between 1970 and 2000. This was below the global average of 9.2 percent for the world as a whole, so by 2001 SSA accounted for just 0.15% of world food aquaculture output. It should be noted that if China is excluded a more sanguine picture emerges; the world growth rate of aquaculture falls to 6.3 percent, with a relative improvement for SSA.

The reasons for aquaculture's slow growth in SSA are multiple (Brummett and Williams, 2000). Aquaculture is not indigenous to sub-Sahara Africa; it was introduced during the colonial period as an adjunct to sports fishing (Machena 1999). While there has been trout farming in South Africa since the 1850s and in Kenya since the 1920s, the fish were destined to stock waterways for sports fishing. Catering to the recreational needs of the colonialists, aquaculture had little impact on rural Africans (Kalinga, 1990). Not until the 1950s when fish was perceived as a food source did aquaculture develop. Thus in comparison to Asia, aquaculture in sub-Sahara Africa is recent; feeding of fish and water management has not been part of husbandry tradition.

In comparison to Latin America where aquaculture output has grown more than twice as fast as SSA, there has been no "early mover" such as Chile to have a demonstration effect on other countries. Chile, (the largest producer in Latin America) produced only one-tenth Nigeria's output in 1980, by 2001 Chile's output was more than twenty times that of Nigeria (the dominant producer in SSA).

In addition to these reasons, another explanation for the slow growth has been the failure to recognize economic incentives. In the 1970s a wave of expansion occurred driven by international donors with a focus on poverty alleviation and small-scale rural aquaculture, but many of the projects failed to take into account the economic needs of the farmers, and small as it was, output from aquaculture actually declined by about 10% between 1974 and 1985 (King, 1993). In many places ponds progressively deteriorated; one study undertaken in Ghana reported that by 1989 more than one-fifth of the ponds constructed in the 1980s had been abandoned (FAO, 1989). Sustainability after the departure of donors was a problem, particularly in the context of structural adjustment programs and government budget constraints. In a retroactive review of 54 aquaculture projects, less than ten were rated as having "good sustainability" (Coche, et. al, 1994). The major cause was inadequate financial support. Extension services and government stations that supplied fingerlings to rural farmers could not be maintained out of public monies once donors departed. If it is unprofitable, aquaculture cannot be sustained without continued government funding (Pillay, 1997). An example is the failure of tilapia culture in the Senegal River basin. Farmers lost interest in growing tilapia because the economic rewards were unattractive (Diouf and Albaret, 1996). In Zambia, the indicator of success of some donor-funded projects was the number of fish produced. The aim

was to produce as many fish as possible regardless of costs. Once grant funding ended, so did the unprofitable farms (Soma, et. al., 1999).

Markets and relative prices were also ignored. Market forces were the impetus behind Egypt's successful aquaculture. Only when the price of fish increased as the commercial sardine fisheries were disrupted in the Delta because of the Aswan Dam, did aquaculture in Egypt became profitable and develop (Mellac, 1995). However, Kenyan fish farming was promoted even in non fish-eating communities in the Central Region (Coche, et.al., 1994). In other cases demand for the aquaculture product was non-existent because the high-end market demanded quality and would not accept non-standard fish coming from the rural aquaculture sector. Alternatively prices of aquaculture output were high compared with prices of pelagic fish from the commercial fisheries. In Zimbabwe, cultured fish could not compete against imports of cheap horse mackerel from Namibia (Balarin, et. al, 1997). Failure to take into consideration economic incentives and markets has been a common feature of aquaculture projects in Africa.

However farmers in SSA are motivated by the same economic calculus as in Asia and Latin America, and respond to incentives. This is illustrated by commercial seaweed farming in Tanzania / Zanzibar (Pettersson-Lofquist, 1995). Begun in 1989 output of commercial algae is now approaching 7,000t a year (6,000 of *Eucheuma spinosum* and 1,000 of *E. cottonii*), mostly on Zanzibar. Approximately 7,000 families receive US 1 million in direct payments and this in a region where average annual incomes are US$100. Most (90%) of the farmers are women for whom seaweed is the only source of cash income.

Similarly Madagascar has privatized fish stations leaving fingerling supply to the private sector. It has also attracted direct foreign investment, which was the strategy adopted by Chile. Its annual aquaculture output growth rate during 1992-2001 was 19%, an annual rate of growth higher than the global average. Expanding shrimp production (for export) has more than offset declines in carp production. At the moment in second position in the region by volume (after Nigeria), a continuation of present growth rates would see Madagascar surpassing Nigeria's output by 2010, and become SSA's principal producer.

As Table I shows, output from the region is dominated by a few countries with the majority

having little or no production. Of the regional output, 44% comes from Nigeria alone, with Ghana, Madagascar, South Africa, and Zambia each producing more than 4,000t a year. These dominant five producers account for almost 90% of the region's output. As can be seen West Africa and Nigeria dominate, but southern Africa, particularly Madagascar, have experienced the most rapid expansion.

Table 1 Aquaculture Output (excl. aquatic plants) in tons in SSA 1989-2001

	1989	1991	1993	1995	1997	1999	2001
CENTRAL							
Congo, DR	760	700	700	750	750	414	400
Sub Total	**1,294**	**1,233**	**1,451**	**1,482**	**1,374**	**1,381**	**1,511**
EAST							
Kenya	972	1,178	1,,145	1,302	199	300	1,009
Tanzania	600	500	200	200	200	200	300
Uganda	42	63	87	194	360	475	2,360
Sub Total	**1,900**	**2,130**	**1,893**	**3,163**	**2,641**	**2,428**	**5,012**
SOUTH							
Madagascar	230	198	2,289	4,712	8,582	5,811	7,749
Malawi	217	223	256	226	231	590	568
Mozambique	24	19	10	37	0	0	0
South Africa	2,058	4,907	4,028	3,535	4,196	4,143	4,177
Zambia	1,180	2,470	4,655	4,081	4,800	4,180	4,200
Zimbabwe	165	142	140	165	185	185	200
Sub Total	**3,937**	**8,019**	**11,438**	**12,858**	**18,067**	**14,974**	**16,974**
WEST							
Côte d'Ivoire	168	253	351	386	450	1,000	1,025
Ghana	330	410	465	550	400	2,900	6,000
Nigeria	25,840	15,365	17,090	16,619	24,297	21,737	24,398
Senegal	11	12	26	60	74	155	151
Sub Total	**26,456**	**16,127**	**18,238**	**17,905**	**19,243**	**26,530**	**32,092**
TOTAL SSA	**33,3611**	**27,390**	**32,908**	**34,977**	**47,045**	**45,240**	**55,375**

Source: FAO Fishstat Plus 2003

In spite of the sector's small output and uneven development, there are reasons for cautious optimism for aquaculture. On the demand side, there is a sizeable and growing shortage of fish, and on the supply side there are the resources for aquaculture expansion. Per capita consumption of fish in SSA is among the lowest in the world; at 6.7kgs per person a year, less than half the

developing world average of 14.0kgs. This is important for nutrition because SSA as a whole is very dependent on food fish for protein. While fish provide on average 15.3 % of all animal proteins world-wide, in SSA the average is higher at 22.8% (FAO, 2003c). Moreover in certain coastal states of West Africa (Ghana, Sierra Leone and Gambia) the proportion exceeds 60%.

In addition to domestic demand there is the potential for exports. Catfish and carp are cultivated but their output fluctuated during the 1990s, and in the case of carp actually fell. The principal species cultivated in SSA is the tilapia which represented 32% of regional production in 2001, and tilapia fillets are being exported to Europe. The fastest growing species has been shrimp (largely due to Madagascar); by 2001 crustaceans accounted for 11% of regional output by weight. Their market is also Europe.

To meet the growing demand for food fish, Africa is fortunate that it has the resources to expand aquaculture. In some countries, such as Zimbabwe and Rwanda, land is scarce but most countries in central and southern Africa have ample land (Sen, et.al., 1997). The region also possesses vast inland waterways, with the larger bodies alone covering 520,000 km^2 (FAO, 1996). In humid West African tropical zones, water has typically been so plentiful that knowledge about water and water management is only recent (Oswald, et.al, 1996). With existing water availability and climatic conditions, a GIS study concluded that the potential area for cultivation of tilapia (*O.niloticus*) and African catfish (*Clarias gariepinus*) in southern Africa was large (approximately 23% of the land area), with less than 5% being used (Kapetsky, 1994). A later study refined the specifications for commercial farming to incorporate the population size of urban centres and travel time, and included common carp *Cyprinus carpio* (Aguilar-Manjarrez and Nath, 1998). Results indicated that 43% of continental Africa had the potential for farming the three species commercially. Moreover, 15% of that area was the "most suitable", with possible yields of up to 2.0 crops/year for Nile tilapia and 1.7 crops/year for African catfish. Overall 16 countries are very suitable in half or more of their national area for commercial farming of the three species.

2. POLICIES

Surveys indicate that entrepreneurs are reluctant to invest in Africa because of governance issues, such as political and policy instability, arbitrary regulatory decisions, and corruption (World Economic Forum, 1998). There are other factors such as access to capital, and borrowing costs that

may exceed 20 percent in real terms. However empirical studies have demonstrated that governance in the broadest sense outweighs geography as explanations for differences in economic growth (IMF, 2003). If the principal impediment in Africa to private sector investment in aquaculture, or any other sector, is governance, enabling policies can contribute to a more conducive environment. In addition there are policies particular to the sector that can promote aquaculture.

In providing an attractive socio-economic environment for private investment, enabling policies are designed to encourage an efficient functioning of the private sector. Such policies include issues of policy-stability, protected property rights, absence of corruption, and a strengthening of institutional factors, such as bankruptcy laws and contract enforcement, subsumed under the term "governance". Good governance reassures investors that their capital is secure and offers an incentive for further investment. In a survey of firms in Africa, foreign-owned companies ranked political and policy stability as the most important determinant of whether to invest in the Continent and among the principal causes of investment success or failure (World Economic Forum, 1998). Domestic firms also ranked political risk highly, although behind other factors such as taxes, and infrastructure. Nigeria for example was ranked the lowest of twenty sub-Saharan countries when businesses were asked about political instability, the certainty of rules and laws, and the honouring of contracts by governments (World Economic Forum, 1998).

One enabling policy that encourages private sector investment is clarification of property rights. Property rights are important because they affect incentives for producers to internalize externalities. Decisions whether to invest and whether to pollute are affected by property rights. Freely tradable property offers mobility, incentives and collateral. In Africa there is often a dual system of land ownership, with communal rights co-existing with private rights. This is costly and wasteful; the system increases the price of land for investors, and causes land disputes. Few countries have individual land rights and where they are available the land process is usually long, and fraudulent (Platteau, 1992). The Côte d' Ivoire has individual title with no restrictions whereas Kenya and Malawi impose restrictions. Madagascar and Zimbabwe, among others, have a variety of different land rights, and in Nigeria and Zambia land is vested in the state so that individuals only have rights to occupancy and usage. Foreign investors are concerned that land title will not be validated, and occupiers are reluctant to lease in case the rights are transferred to the new user. Other enabling policies are clearly defined and enforced legislation,

and a rapid and transparent regulatory process. The absence of legislation can be a deterrent to investors because it creates uncertainty. The problem is compounded when regulatory processes are administratively cumbersome (Hishamunda and Ridler, 2003).

1 FISH STATION PRIVATISATION

One of the characteristics of aquaculture in sub-Sahara Africa is the existence of government - owned fish stations, many of which are derelict. Built by donors to diffuse knowledge of aquaculture to rural farmers their operating costs could not be met by governments when donor funds were exhausted. They were then abandoned or became derelict. In Ghana only two hatcheries out of twenty are operational (Entsua-Mensah et.al, 1999). Because of the precarious condition of some stations, an appropriate strategy is the divestiture of many fish stations to the private sector. In fact there are recommendations that the number of government stations should be reduced by at least half within five years (Moehl, et. al., 1999).

The advantage of privatising where possible is that it relieves governments of operating costs. Privatization also tends to boost efficient management. This has certainly been the experience when parastatal operations in agriculture have been privatised (Cleaver, 1993). If there is no interest from investors, management at least could be privatized. With the incentive to manage efficiently the station could become profitable sparking interest from local investors. However, there are disadvantages of privatization. Privatization will, at least initially, lead to higher prices of fingerlings. This is almost inevitable in the initial stage and temporary subsidies could be offered to farmers. However over time these higher prices should prompt interest from entrepreneurs, increased supply and an easing of prices. This has been the experience in Madagascar where all fingerling production has been privatised. Privatisation is also likely to lead to job losses because the private sector hires only if labour productivity matches wage rates. Those remaining will receive higher wages that at least partially compensates for the loss of jobs.

Fish stations serve a number of purposes. In the first place they produce fingerlings that may be distributed free or subsidised to farmers. In the second place they are a source of food fish. In some cases lack of money has forced managers to be entrepreneurial selling fish in the market. However this revenue-generating practice may provoke opposition from senior administrators. Managers have been obliged to remit profits to the department, thereby undermining incentives.

Moreover the practice of selling fish from publicly funded stations does not provide a "level playing field" for commercial farmers who face unfair competition. A third purpose is to provide a demonstration to farmers of aquaculture technology and practices. This is important in those areas where water management and husbandry practices are recent. Other purposes of the stations are training and research

The abandonment of fish stations has prompted a recommendation that they be divested of their role as seed producers, as suppliers of food fish and as demonstration centres (Moehl et. al., 1999). Fingerling production would become the responsibility of the private sector, as in Madagascar. While certain of these roles could and should devolve to the private sector, others such as basic research and training belong in the public domain. Because of the uncertain outcome of research and the impossibility to internalize all benefits development research is not attractive to the private sector. Also maintaining the quality of brood stock requires government stations if private fingerling production is more interested in productivity than quality (Little, 1998).

The procedure for divestiture could follow that of parastatal institutions in agriculture, many of which have been returned to the private sector in restructuring programmes (Cleaver, 1993). The first step is to settle liabilities and also often restructure management. As for the actual sale there are a number of possibilities. One approach is for the government to set a price. If there is to be a set price, transparency is important, and private investment bankers are often better equipped than governments to evaluate assets and organize privatization. Another option is a sale by auction. Both procedures pose risks to small-scale farmers. An alternative is to give first right of refusal to local farmers and to encourage them to acquire stations through producer co-operatives. Another is to proceed first with a joint private-public venture with governments selling their shares over time. This requires less initial equity from investors and may be a suitable approach if the intention is to encourage local ownership. It also allows time for management learning and reduces risks. There must however be a commitment for full divestiture eventually.

2 PRODUCER ASSOCIATIONS

The purpose and effectiveness of producer organisations varies but at a minimum they are lobby groups and information providers. In most countries aquaculture does not have the weight of agriculture or even the capture fisheries and so its interests are often overlooked. Producer organisations can be useful just as a lobby group. Moreover they are frequently used for the exchange of information and as a means of diffusing technical information. In its most effective form a producer organisation markets the product ensuring that the quality is consistently high, self-polices regulations and even funds applied research.

In sub-Saharan Africa farmer organisations although numerous have not usually been effective. A review in the early 1990s found that as many as 4,000 co-operatives existed in Nigeria alone with the earliest dating back to1907 (Turtianen and Hussi, 1992). However most were mismanaged and politicised. In at least Ghana, Kenya, and Nigeria co-operative legislation needed revision to permit management autonomy from government, and the marketing of crops. The experience from agricultural associations is that when associations have management autonomy and a business reason to exist they can succeed as with the coffee co-operatives in Kenya (Cleaver, 1993). Self-sufficient financially, and paying market interest rates, farmer's associations have been particularly successful in managing shared water supplies and in Kenya and Nigeria, diffusing processing technology. There exist also some farmer-managed co-operative savings and loans associations in Africa, particularly francophone countries. Co-operative credit institutions in countries such as Benin, Burundi, Cameroon and Ghana have been most successful; mobilizing farmer savings and lending at rates that reflect costs and risk.

Producer groups and model farmers may be required to assist more with extension services and training (Moehl, et.al., 1999). Increasingly in sub-Saharan Africa the cost of separate extension services for agriculture and aquaculture is forcing amalgamation of the two and a unified service, but the disadvantage is that extension workers may be unfamiliar with the less significant sector, aquaculture. To provide adequate technical assistance while minimising public expenditures, extension services focussed on farmer groups and farm leaders could prove advantageous.
As the industry develops producer associations can absorb more of the burden of research. The advantage of producers' co-ordinating research is that the results of the research can be internalized to all members thereby giving an incentive to contribute. It increases aquaculture

research intensity and obviates public expenditures.

In sub-Saharan Africa, while aquaculture is a recent introduction, it has been studied at least as far back as the 1940s and 1950s in certain countries of the region (Entsua-Mensah, et.al., 1999). Yet research results, as reflected in output, have been limited. The low output can be partly attributed to disregard for economic incentives to producers. However part of the problem has been poor research co-ordination and problematic diffusion of research results within sub-Saharan Africa (Coche, et.al., 1994). A solution proposed has been to establish a regional information network (Coche and Collins, 1997). Another factor affecting research efficiency has been the lack of demand-driven research (Entsua-Mensah, et.al., 1999). If the agenda is determined by a top-down approach, existing expertise and interests will orientate publicly funded research. To obtain demand -driven research the private sector has to be involved, either as a source of funds, or as one of the stakeholders setting the research agenda.

CONCLUSION

Aquaculture is the fastest growing source of food in the world and could account for more than half of all food fish by 2020. To encourage its expansion in sub-Saharan Africa private individuals must be encouraged to invest in the sector. Such investment need not be at the expense of rural subsistence aquaculture; in fact there may be mutually reinforcing links in marketing and technical dissemination between rural and commercial aquaculture. This paper has explored some policies that might induce individuals to invest in aquaculture. Enabling policies are an inducement to general investment while sector-specific policies focus exclusively on aquaculture. Two feasible policies are suggested for governments that are fiscally constrained.

BIBLIOGRAPHY

Aguilar-Manjarrez, J. and Nath S., 1998. A Strategic Reassessment of Fish Farming Potential In Africa. FAO CIFA Technical Paper 32, Rome, FAO.

Ahmed,M., Lorica, M., 2002. Improving developing country food security through aquaculture development-lessons fromAsia. Food Policy 27, 125-141.

Balarin, JD., Chishawa, A., Evans, R.,1997. Commercial fish farming poised to take off in Zimbabwe. FAO Aquaculture Newsletter 15, 18-19.

Brummett, R., Williams, M., 2000. The evolution of aquaculture in African rural and economic development. Ecological Economics 33, 193-203.

Cleaver, K., 1993. A Strategy to Develop Agriculture in Sub- Saharan Africa and a Focus for the World Bank. Africa Technical Department Series Technical Paper No 203. Washington, DC, World Bank.

Coche, A., Haight, B., Vincke, M., 1994. Aquaculture Development and Research in Sub-Saharan Africa. CIFA Technical Paper No 23. Rome, FAO.

Coche, A., Collins, J., 1997. Support Aquaculture Developments in Africa: Aquatic Farming Systems Information Network. CIFA Occasional Paper No22. Rome, FAO.

Delgado,C.L.,Wada,N., Rosegrant, M., Meijer, S., Ahmed, M., 2003. Fish To 2020. Washington,D.C.,International Food Policy Research Institute.

Diouf,P., Albaret,J., 1996. Tilapia culture in the Senegal river basin and the causes of its failure. In Pullin R., Lazard, J., Legandre, M., Amon Kothias,J., Pauly,D., eds., The Third International Symposium on Tilapia in Aquaculture ICLARM Conf. Proceedings, Manila, ICLARM.

Duncan, A., 1999. The food security challenge for southern Africa. Food Policy 23, (6), 459-475.

Entsua-Mensah,M., Lomo,A., and Koranteng, K., 1999. Review of Public Sector Support for Aquaculture in Africa. Background paper for the Review of Aquaculture in Africa. Accra, FAO.

FAO, 1989. Report on Aquaculture in Ghana . TCP/GHA/ 0051. Rome, FAO.

FAO, 1996. Fisheries and Aquaculture in Sub-Saharan Africa: Situation and Outlook in 1996 FIP Fisheries Circular No 922. Rome, FAO.

FAO, 1999. Aquaculture Production Statistics 1988-1997. Rome, FAO.

FAO, 2003a. The State of Food Security in the World. Rome, FAO.

FAO, 2003b. State of Fisheries and Aquaculture. Rome, FAO.

FAO, 2003c Food Balance Sheets. Rome: FAO.

Hishamunda, N., Ridler,N., 2003. Sustainable commercial aquaculture: a survey of administrative procedures and legal frameworks. Aquaculture Economics and Management 4, 167-178

IMF, 2003. World Economic Outlook. October, Washington,D.C.,IMF.

Kalinga O., 1990. The evolution of fish farming in Malawi. In Costa-Pierce,B., Lightfoot, C.,

Ruddle, K., Pullin, R., eds., Aquaculture Research and Development in Africa. Manila, ICLARM.

Kapetsky, J., 1994. A Strategic Assessment of Warm Water Fish Farming Potential in Africa. CIFA Technical Paper No 27. Rome, FAO.

King, H., 1993. Aquaculture development and environmental issues in Africa. In Pullin, R., Rosenthal,H., Maclean, J., eds., Environment and Aquaculture in Developing Countries. Manila, ICLARM.

Little, D., 1998. Options in the Development of the Aquatic Chicken. Fish Farmer July, 35-37

Machena, C., 1999. An Analysis of Aquaculture Trends in Africa (mimeo). 1999.

Machena, C., Moehl, J., 2001. Sub-Saharan African aquaculture: regional summary. In Subasininghe, R.P., Bueno, P., Phillips, M., Hough, C., McGladdery,S., Arthur, J., eds. Aquaculture in the Third Millenium. Rome, FAO.

Maxwell,S., Slater R., 2003. Food policy old and new. Development Policy Review 21 (5-6), 531-553

Mellac, S., 1995. Les Conditions de Developpement pour l'Aquaculture Africain. Nations Unies Commission Economique pour l'Afrique. Division de l'agriculture. Monographe No 15 Addis Abeba, Onu-CEA.

Moehl, J., Coche,A., and Sagua,V., 1999. Africa Regional Aquaculture Review. CIFA Occasional Paper. Accra, FAO.

Oswald,M., Copin,Y., Montferrer, D., 1996. Peri-urban aquaculture in mid-western Cote d' Ívoire. In Pullin, R., Lazard,J., Legandre, M., Amon Kothias,J., Pauly, D, eds., The Third International Symposium on Tilapia in Aquaculture. ICLARM Conf. Proceedings.

Pettersson-Lofquist, F., 1995. The development of open-water algae farming in Zanzibar: reflections on the socio-economic impact. Ambio 24 (7-8), 487-491

Pillay,T.,1997. Economic and social dimensions of aquaculture management. Aquaculture Economics and Management 1, p.3-11

Plateau,J., 1992. Land Reform and Structural Adjustment in Sub-Saharan Africa. FAO Economic and Social Development Paper 107. Rome, FAO.

Sen, S.,van der Mheen, H.,van der Mheen-Sluijer, J., 1997. The place of aquaculture in rural development. In Martinez- Espinosa,M., Report of the Expert Consultation on Small-Scale Rural Aquaculture, Fisheries Report No 548. Rome, FAO.

Soma,K., Mwango, J., Mazingaliwa, K., 1999. Analysis of Fish Culture in Zambia. Japan International Cooperation Agency, Tokyo, JICA.

Turtianen T., Hussi, P., 1992. Nigeria Co-operative Movement. Western Africa Technical Report, Washington, D.C., World Bank.

World Economic Forum, 1998. The Africa Competitiveness Report. Geneva, World Economic Forum.

World Economic Forum, 2000. The Africa Competitiveness Report. Geneva, World Economic Forum.