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REPORT OF THE FAO-WORLDFISH CENTER WORKSHOP ON SMALL-SCALE AQUACULTURE IN SUB-SAHARAN AFRICA: REVISITING THE AQUACULTURE TARGET GROUP PARADIGM

Limbé, Cameroon, 23–26 March 2004

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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PREPARATION OF THIS DOCUMENT

The 1999 Africa Regional Aquaculture Review (CIFA OP24) concluded that most countries in the Africa region are focusing on small-scale integrated aquaculture systems producing tilapia and/or catfish. The Review further concluded that: (a) aquaculture is now known throughout Africa as a result of previous extension efforts and (b) adoption/acceptance, even if on a modest scale, has been noted in most countries. The Review *inter alia* recommended that extension efforts should be focused on small-scale model farmers operating under favourable conditions (water and soil, interest and dynamism, experience with other resources, etc.) and that research to support small-scale aquaculture development should be farmer-driven and based on inputs commonly available to small-scale farmers.

In 2003, the prominence given to small-scale aquaculture prompted the Inland Water Resources and Aquaculture Service, through the Fisheries Department Group of the FAO Regional Office for Africa, to schedule a regional workshop on this subject. As a result, FAO contracted the WorldFish Center West Africa Office in Yaoundé, Cameroon, to facilitate and organize this workshop in early 2004. The workshop assembled senior aquaculture officers from the region as well as development experts representing bi- and multilateral organizations.

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ABSTRACT

In response to an increasing interest in sustainable aquaculture among governments and international donors, the Food and Agriculture Organization of the United Nations (FAO) and the WorldFish Center undertook a review of how aquaculture is targeted in sub-Saharan Africa as a first step in the identification of appropriate extension approaches and production strategies that would suit the various technology user-groups. Representatives of senior fisheries management agencies from nine countries in the region met to discuss progress, opportunities and key constraints to aquaculture development.

Through a series of presentations, working group sessions and plenary discussions, broad consensus was achieved on the way forward for African aquaculture. In an effort to realize the goals of aquaculture, an attempt was made to develop a set of practical recommendations that can be used by national governments to insure that the major constraints are being addressed and that the major opportunities for aquaculture are capitalized upon to increase the contribution of aquaculture to food security and economic growth.

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1. WELCOMING STATEMENT FROM THE CAMEROONIAN DIRECTOR OF FISHERIES

Cameroon is happy to have hosted this Workshop as a logical regional follow-up to the assistance provided by FAO and WorldFish Center to the Government of Cameroon in elaborating a national Strategic Framework for Aquaculture Development. In Cameroon, as elsewhere across the Africa region, there is growing awareness of the importance of aquaculture as well as an improved understanding of the shortcomings of earlier efforts to establish sustainable aquaculture, especially fish farming, in the country. It is now incumbent on all of us, politicians, administrators, technicians and producers to learn and profit from the lessons of these initial endeavours and implement field level activities which can facilitate a private sector driven aquaculture subsector that can meet its expectations. If these expectations are, indeed, to become realities we must all adopt new attitudes to aquaculture development, enhance the returns to scarce resources and optimize the energies which our farmers so ably demonstrate in their eagerness to grow profitable crops of fish and other aquatic organisms. We must use the existing knowledge base to our advantage, focus and carefully target our interventions and foster increased public sector investment as the public sector divests archaic and redundant infrastructure. If we are able to make the hard decisions and act with prudence and expediency, we will soon be able to have farm-raised aquatic products in our markets and on our tables.

2. LIMBÉ DECLARATION

A consensus Statement by Delegates to the FAO/WorldFish Center Workshop on Small-scale Aquaculture held in Limbé, Cameroon, 23–26 March 2004

Aquaculture development in sub-Saharan Africa (SSA) is at a crossroads. Burgeoning population growth and declining natural sources of fish make it imperative that aquaculture contributes as substantially to continental fish supply as possible. The region is the only one in the world where per capita fish consumption is declining and is project to decline further. Reasons for this situation include: civil conflict, weak management structures, low levels of investment in rural economies and lack of economic growth. At the same time, however, new opportunities exist that brighten the prospects for aquaculture development.

In many countries, policies of privatization and decentralization provide incentives for increased investments in the sector from private and public sources as domestic markets, especially in urban areas, become more accessible and trade expands. At the global level, the ever-growing demand for fish has created opportunities for export-oriented aquaculture production. The challenge today is to make use of these opportunities for the sustainable development of aquaculture in the region. There is a need for a type of development that contributes to national food security and poverty reduction objectives and pays attention to the scope for expansion that the nature resource base allows.

Sub-Saharan Africa must, therefore, make a choice, either for "business as usual" and things continue as they are, and people live with the dire consequences, or it is "time to make hard choices", institute relevant policies and strategies, bring aquaculture into the formal cash economy and stem the tide that is undermining aquaculture's future. To this effect, many governments, cooperating partners as well as bilateral and multilateral development agencies are developing a new strategy for aquaculture development in sub-Saharan Africa.

The meeting recognized a number of constraints to the development of aquaculture, which includes seed and feed production, as well as inefficient extension and outreach. The delegates to the workshop further acknowledge that:

- Support to a knowledge development and delivery structure to provide essential assistance for aquaculture from government and those providing external aide requires convincing demonstrations of impact on national development priorities such as poverty reduction, food security, nutrition, human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) and sustainable environmental management.
- Institutional stability and durability will be achieved through structures that rely first and foremost on private sector investments as well as on output-oriented and accountable use of public revenue which aims at enhancing sustainable development of aquaculture.
- Public/private partnerships between investors and knowledge delivery structures can facilitate sectoral growth by providing farmers with the highest quality of technological, managerial and marketing information available while public/civil society connections in such structures can help ensure the optimization of public goods from the perspective of producers at all levels.

While appreciating the need to address the three major constraints identified (seed, feed, extension), the meeting called upon the governments and cooperating partners as well as research agencies to focus on the likely development impact of investment in these areas. In order to ensure optimum impact of development strategies aimed at the major

constraints, there is a need to examine other areas, such as market development, access to capital and other policy issues that might be deemed relevant and equally important.

Furthermore, participants propose that SSA Governments should seek to develop Public Private Partnerships within the growing number of aquaculture enterprises, by creating cost-effective financial and institutional arrangements that can compliment government and donor resources to deliver a limited number of critical research, advisory and technological services to high-potential farmers.

Participants further pronounced that the approach to national aquaculture development, based upon the Cameroonian Strategic Framework for Aquaculture Development addresses the major constraints to expansion of the subsector in the region, facilitates the necessary public/private and public/civil society linkages as well as proposes mechanisms to maximize returns to the investment of both public and private sector resources.

While endorsing this approach as an appropriate tool to foster aquaculture development, participants noted that such strategic approaches can only achieve their expected goals when efforts make use of existing national strategies, master plans and investment plans for aquaculture development in order to harmonize, to build synergies and to eliminate redundancies. These efforts involve national partners and stakeholders, but also aquaculture producers, support services, local authorities and investors from the public and civil society sectors, cooperating partners (donors) as well as international and multilateral organizations.

The meeting envisages that aquaculture in SSA will grow into an important pillar of development in many areas in the region. It will be able to provide high quality food for rural and urban consumers, generate employment and general commercial activities in otherwise impoverished local economies, and contribute to national wealth through increased revenue from markets and trade. In order to achieve this vision, the countries in the region need to work together to increase their knowledge base, exchange best practice experiences and speak with one voice in the global marketplace.

3. THE WORKSHOP

3.1 Introduction

In Africa aquaculture is growing in terms of intensity and productivity. The main types of investors are commercial and non-commercial. Within these domains, there exists a wide range of investment strategies from small- to large-scale. Two main groups dominate: large-scale commercial producers and small-scale artisanal producers. For small-scale artisanal producers, aquaculture increases revenues, crop diversity and ecological sustainability, while lowering risk and improving resilience. The vast majority of African fish farmers (probably more than 90 percent) fall into this category. A much smaller number of large-scale commercial fish farms generate food, jobs and considerable revenues in both export and local markets. Although it is not always well documented, the impacts of both of these groups are considerable and important.

However, most experts agree that small- and medium-scale commercial enterprises are the most efficacious engines of economic growth. Researchers at the International Food Policy Research Institute found that *"… even small increments to rural incomes that are widely distributed can make large net additions to growth and improve food security."* The CGIAR has identified interventions that lead to improved incomes at the level of the rural farmer and resource manager as *"having a larger impact on countrywide income than increases in any other sector".* To increase the benefits accruing from aquaculture, development planners should consider how to move from the current situation of dominance of small-scale artisanal/large-scale commercial investors, to one where there are many small- and medium-scale commercial investors, without losing the benefits currently being generated by aquaculture.

To advance the collective thinking on how to best encourage the development of aquaculture, particularly in light of the problem of fingerling quality and quantity, for the purposes of generating food, income and economic growth, FAO and the WorldFish Center were jointly organizing a four-day strategic planning workshop with the objectives:

- Develop consensus on the current status and way forward for small-scale aquaculture in Africa.
- Identify partnerships that can develop and undertake projects with high probability of success.
- Elaborate concepts for intervention that take advantage of the capacities of partner agencies.

3.2 Definition of terms

Aquaculture has often been classified by those involved in the subsector in an attempt to better monitor its growth and development. This categorization has frequently been done in terms of intensity or size; extensive, intensive or semi-intensive operations of small-, medium- or large-scale. Such nomenclature has a high level of subjectivity: "How big is big?" and "How extensive is extensive?" For nearly every situation there are noteworthy exceptions; small, intensive operations along with large, extensive operations. Moreover, within a system based on magnitude – either size or intensity – there is an underlying assumption that size matters; that, all things being equal, producers would opt for larger or higher intensity operations. However, this assumption exists with little idea as to what producers' expectations truly are.

It is now understood that the motivation of the producer is the key to production. As motivation becomes a more important criterion than the production facilities themselves, the priorities and investment strategies of producers become central determinants. With this analytical approach, one quickly identifies the two major types of investors mentioned in the previous section: *commercial* and *non-commercial*; with *industrial* a subset of the first category.

Commercial producers are defined as those who are:

- profit-oriented;
- small-, medium- or large-scale;
- active participants in the market;
- purchasing inputs (including capital and labour);
- engaged in off-farm sales of the fish produced; and
- aquaculture is among their principal economic activities.

As a relatively small component of the commercial category, *industrial* farms and farmers are typified by:

- agri-businesses where the scale is one of level of capital;
- where the produce is often traded on the global market; and
- where the technical assistance needs are in the form of policy, legislation, monitoring, regulation, etc.

Non-commercial farmers:

- may also purchase inputs, mainly seed and feed;
- rely chiefly on family labour and on-farm sales of the produce; and
- consider aquaculture being one of the variety of enterprises comprising the farming system, undertaken to diversify production, to improve resource use and to reduce risks of such events as crop or market failure.

Numerically, the majority of fish growers in any given area may be non-commercial producers and this group certainly constitutes the majority of the constituency in the Africa Region. Yet, commercial farmers serve a critical role, because:

- they are motors of aquaculture development, willing to invest capital in their enterprises;
- they create demand for high quality inputs;
- they catalyse producer groups; and
- they demand services.

For commercial producers to function in this essential way, they must have a critical mass, i.e. a density dependent factor requiring an economically viable "weight"

(e.g. surface area, tonnage etc.), and be present in an economically viable zone. Viable commercial producers will pull down benefits to non-commercial farmers who will inevitably share the same economic zone.

Many early aquaculture development theorists felt the successful establishment of aquaculture enterprises was best reflected by a continuum along which a given farmer would move. This path was seen as being resource limited and as farmers acquired more resources, including knowledge, their yields would improve accordingly. Nonetheless, several decades of empirical data have indicated a clear trend of farmers practising low-input/low-output aquaculture rarely progressing far beyond their entry point in terms of yield. In fact, first harvests may well be the largest these farmers achieve. Aquaculture development is now not seen as a series of vertical leaps as farmers reach higher and higher levels of production; it is rather viewed as a set of discrete enterprises where the farmers' motives for adoption remain basically the same and increases are only those that can be easily obtained within the specific range of production technologies near the level where the farmer entered. In this scenario, non-commercial farmers rarely "graduate" to commercial levels but remain non-commercial, even if they do make progress in increasing their relative efficiency. While some innovative farmers may spontaneously jump to higher strata, most farmers move up levels only when management or the economic environment significantly changes.

In this context, it is the concept and not the exact nomenclature that is innovative: farmers should be viewed in terms of their prime motives for embarking on aquaculture enterprises. It is understood that the delineations between classifications are a bit murky and may even seem arbitrary. It is also understood that knowing enough about farmers' motives requires a new set of priorities and methodologies for those whose objective is to aid these farmers to gain efficiency. Yet, the alternative to revising our approach and accepting the challenge is to keep using old tools that have proven their inability to address satisfactorily the key issues at hand.

3.3 Lessons from recent aquaculture development projects

A number of reviews of African aquaculture development has been undertaken in the last decade in an attempt to identify key constraints and opportunities for success. To update these studies in the light of new knowledge gained through newer research and development activities on the ground, a review of recent projects was undertaken and reported to the plenary. The projects reviewed were:

- Ghana/FAO: Strengthening Organizational Capacity of Fish Farmer Associations (2002–2004);
- Uganda/FAO: Assistance to Fish Farmers in Eastern Uganda to Improve Fish Seed (2002–2004);
- Guinea Conakry/FAO: Support to Rural Fish Farming Development in Guinea Forests (2001–2003);
- Cameroon/FAO: Appui à la composante diversification du Programme spécial de sécurité alimentaire, aquaculture (2003–2005);
- Zambia/US Peace Corps: Zambia Aquaculture Project in Northern and Northwest Zambia (1996 to date);
- Democratic Republic of the Congo (DRC)/United States (US) Peace Corps: Family Fish Farming Project (1979–1990).

The knowledge gained from these interventions has generally supported the view that aquaculture can be successful if it is well focused and addresses farmers' needs and constraints. Critical concerns and salient features of successful interventions are outlined below:

Project formulation and approach

- Fish culture can be introduced and established in new sites without any external assistance beyond the provision of technical information (e.g. no credit, gifts, incentive, subsidies, etc.).
- Aquaculture development projects are generally too short (1 or 2 years).
- Most newer projects have usefully and successfully taken socio-economic aspects into consideration in project design and implementation.

Aquaculture extension

As part of the regional review, the recent history of aquaculture extension in five representative countries (Cameroon, Ivory Coast, Kenya, Madagascar and Zambia) of sub-Saharan Africa was analysed. Country reviews were commissioned and synthesized. A number of extension guides, field manuals and dissemination tools were compared. Each of the reviewed countries has a similar history of aquaculture development, beginning with colonial experiments in the 1950s, through a period of neglect following independence in the 1960s, a period of intense international involvement in small-scale rural development (including aquaculture) in the 1970s and 1980s, ending in a period of reflection on results in the 1990s. Many of these past projects were driven by foreign donors interested primarily in poverty alleviation and working on national food security targets, ignoring the desires and constraints faced by would-be producers and beneficiaries. Working within the broader context of rural development, rather than the somewhat simpler world of commercial aquaculture technology, has created problems for poorly trained and motivated extension agents. New participatory paradigms have been

incorporated into policy and planning, but are generally not reflected in the day-to-day work of either research or extension, leading to low rates of adoption and project sustainability. Extension systems based on the Training and Visit Model continue to dominate aquaculture extension in Africa. More sustainable gains made through participatory approaches, however, are leading more and more governments in the direction of farmer-led approaches. Some countries have moved faster to capitalize on lessons learned than others. Madagascar has made great advances based on establishing a close working relationship between small-scale farmers and private sector hatcheries. Zambia has profited from a commitment to integrated agriculture-aquaculture systems and participatory approaches. Cameroon, Ivory Coast and Kenya have lagged behind, but report some local successes with the use of participatory research initiatives. Lessons learned from these experiences lead the authors to the conclusion that aquaculture can play a much larger role in economic development if user interests and knowledge are better incorporated into research and extension processes, and if the quality of the extension services can be upgraded to ensure that good technology is made available to users. Important points to note include:

- There are a good number of well-trained aquaculture technicians in SSA. What is lacking is the experience how to transfer appropriate information to a given target group.

- Successful extension techniques and methods depend on the target group/farmer and his/her socio-economic environment and farming system. There is high specificity for technology adapted to each particular farming system. Classroom training is generally not profitable for small-scale fish farmers. Emphasis on practical aspects helps farmers to understand and improve their farms.

A particularly successful extension model stems from the experience of, *inter alia*, the DRC/US Peace Corps: Family Fish Farming Project. Mobile teams for aquaculture extension were commissioned and operationalized along the lines presented in Appendix 4. Key constraints to the use of such mobile teams were identified as: 1) cost of team support (esp. allowances, fuel and vehicle maintenance) and 2) lack of a formal, field-level link between public extension services and the mobile team. This latter link is especially important in the identification of farmers and corrects targeting of the mobile teams' efforts.

Fish farmer associations

- Most aquaculture development stakeholders see fish farmer associations as important components for sustainability of aquaculture development. Unfortunately, few of these groups presently exist outside of a project context and it is unclear how group dynamics will affect long–term viability.

- The sustainability of fish farmer associations is better in cases where there are common goals and objectives as well as obvious reasons for collective action (e.g. collective marketing, fingerling production and credit).

- To succeed, farmer support groups must originate from the farmers themselves and not be imposed by outside actors.

Participatory approaches

- When doing interviews most farmers change their response according to donor's orientation and expectations.

- In general, farmers expect some kind of financial subsidy from donors or projects. This is because of general political corruption that pervades African development, and early projects that centred on giving material and other form of financial assistance to engender rapid short-term increases in yield.

Record-keeping

- Most fish farmers, especially those operating at smaller scales, consider record keeping an onerous task. As a result, accurate pond records are sorely lacking. Most fish farmers do not see the importance of such data.

Credit

- Results from Guinea Conakry and the DRC show that many farmers have access to at least minimal credit through a range of village-based initiatives.

Non-governmental organizations (NGOs)

- NGOs with adequate technical expertise in fish farming are rare or do not exist in the region. Most NGOs are good at group formation.

The role of the public sector

- Although some governments in sub-Saharan Africa are willing to make an effort to encourage small-scale aquaculture for rural communities, rarely is it a priority.

- The lack of adequate information collection is a major constraint to proper project/programme planning in the region.

Pond management

- Although seeming simple, good pond management is difficult to implement. One-time tasks, such as good pond construction, are more easily accomplished than continuous tasks such as regular and adequate fertilization.

- Farm integration is not a new concept to many farmers. Integrated aquaculture thus can build upon indigenous knowledge and thus create more sustainable systems than introduced technology.

- Use of on-farm inputs can realize good yields. In the DRC, for example, maximum yields were in the range of 4–8 tonnes/ha/year, while in Guinea an average of 5 tonnes/ha/year was achieved on farms using only agriculture by-products.

- Availability of supplementary feeds is often constrained by macroeconomic parameters, in particular transport costs and competition with the livestock sector.

Fingerling production

- When establishing seed production units, it is imperative to take into consideration the critical mass of commercial fish farmers that represents the market for fingerlings.

- Introductory fingerling production systems work better. They start with species that are easy to grow, but which will not reproduce in the pond during the grow-out cycle (e.g. Clarias catfish, mono-sex tilapia). Otherwise, fish farmers are tempted to use their own offspring, lowering genetic quality.

3.4 Presentation of the framework for an aquaculture outreach strategy in Cameroon

Background

The elaboration of this framework has been undertaken in a political context where there is a shift in paradigm necessitated by changing macro-economic conditions. The framework has been elaborated over a period of 10 days by a team composed of experts from the Ministry of Livestock, Fisheries and Animal Industries (MINEPIA), the FAO, the Development Agriculture Research Institute (IRAD) and the WorldFish Center. As a result, government has adopted policies of economic liberalization along with divestment of public sector infrastructure and services in favour of private sector intervention. This is underpinned by a renewed emphasis on good governance as an essential part of the development of all sectors of the country's economy. These policies require that government shifts from playing the role of investor and corporate manager to that of facilitator and regulator; civil society being in charge of developing the economy. With respect to the aquaculture subsector, this area of production remains underdeveloped, in spite of its reported potential and multiple past efforts to stimulate its growth. There is a need for strategic guidelines for the integration of the subsector into the new political and economic environment.

Aquaculture development objectives

Currently, Cameroon meets only half of domestic demand for fish, with aquaculture contributing less than 0.1 percent. Recent trends indicate that, like elsewhere, most natural fisheries have reached or exceeded maximum sustainable yields. Fish imports to satisfy local demand require hard currency, which is often lacking or scarce. Additional fish supply should come from aquaculture. Existing estimates indicate that inland aquaculture can be increased by over 50 fold, covering close to 5 percent of the local demand. Satisfying local demand through increased aquaculture production can improve food security. By providing opportunities for import substitution and export of fish and other aquatic products, aquaculture development can also improve the country's balance of trade. Likewise, the generation of employment, on-farm and in service industries such as processing, marketing and input supply, can increase income and reduce poverty. In addition, increasing the efficiency of water use and adding value to agricultural by-products used as nutrient inputs can reduce pressure on natural resources and the environment.

Within this context, the objectives of the aquaculture subsector in Cameroon are to:

1. Meet local demand and assist in balancing trade in aquatic products.
2. Create employment opportunities in both urban and rural areas.
3. Improve efficiency of natural resource management.

The aim of this Strategic Framework is to suggest the ways of developing sustainable aquaculture that achieves the above-stated objectives.

Approach to framework definition

The elaboration of a Strategic Framework is the first step in the process of elaborating a detailed development strategy. The framework provides the skeleton to be filled out in the process of defining the strategy. During the course of the framework development mission, the authors met with policy makers from the MINEPIA, a number of managers of government fish stations, fish farmers and the FAO Representation in Yaoundé. The Strategic Framework was presented for discussion and adoption in a three day national

workshop which was held in the “Palais des Congrès”, Yaoundé, from 10 to 12 December 2003. The workshop also defined follow-up actions to the Strategic Framework.

Definition of the Strategic Framework

Identification of high-potential aquaculture zones

In most countries, the biophysical[1] and socio-economic[2] potential for aquaculture is not uniform, with some zones having greater intrinsic capacity for aquaculture growth than others. A first step in determining where resources to develop aquaculture could be efficaciously used is the identification of those areas with highest potential. This screening should be supplemented with a comparison of existing aquaculture activities, including the concentration of existing producers and the presence of government and other infrastructure[3]. Zones based on biophysical and socio-economic potential may well be subdivided into areas that correspond to input supply/delivery. For example, to the extent that private seed supply comes from specialized private hatcheries, these hatcheries will operate within areas circumscribed by the economic ability to deliver seed to producers.

Definition of types of aquaculture

Categorising fish farmers and farms according to relative sizes, degree of capitalization and profit motivation is always difficult. In the aggregate, these categories are part of a spectrum that covers the full scope of production systems[4]. If this spectrum reflects production intensity and investment level, individuals at the low end will likely internalize their aquaculture activities with little contribution to the public purse and little benefit from public services. Conversely, individuals at the high end of the scale may make important contributions to national aquaculture production but have relatively little need of public support. For the purposes of this framework, producers have been divided into two categories: commercial and non-commercial. Commercial producers can be small-, medium- or large-scale, and are active participants in the market. They purchase inputs (including capital and labour) and engage in off-farm sales of the fish produced. For these individuals, aquaculture is a principal economic activity[5]. Non-commercial producers may also purchase inputs, mainly seed and feed, but rely chiefly on family labour and on-farm sales of the produce. An additional feature of non-commercial aquaculture is that it is but one of the variety of enterprises comprising the farming system; it is undertaken to diversify production, improve resource use and reduce risks of such events as crop or market failure.

Definition of an appropriate framework for aquaculture outreach

Some level of technical information dissemination is generally considered as necessary to support the aquaculture subsector. This is achieved through public-sector-supported outreach. Drawing upon a wide range of published experiences, a general approach to

[1] Biophysical criteria include water quantity and quality, ambient temperature, soil quality and water holding capacity, etc.
[2] Socio-economic criteria to evaluate include cultural aspects, availability of inputs (fingerlings, feeds, fertilizers), access to markets, range of partners, production technologies, etc.
[3] FAO. 1998. *A strategic reassessment of fish farming potential in Africa*, by Aguilar-Manjarrez, J. & S. S. Nath. *CIFA Technical Paper 32*. Rome.
[4] An aquaculture system is a combination of type of culture unit, level of intensity, culture species and scale or size of exploitation.
[5] In addition to these characteristics, commercial aquaculture can be defined as the farming of aquatic organisms, including fish, molluscs and crustaceans and aquatic plants with the goal of maximizing profits. Thus, the distinction between commercial and non-commercial aquaculture operations relies primarily on the existence or absence of a business orientation and on how factors of production such as labour will be paid.

supporting the development of aquaculture can be suggested. This is based on the premises that:

- some long-term technical assistance for producers is necessary;
- generalist/unified extension services often lack the specific technical expertise to assist aquaculture producers; and
- extension services dedicated to aquaculture assistance must be limited in scope because of the corresponding limitations in human and financial resources.

In this light, high-quality technical support[6] needs to be carefully assembled and targeted. This can best be achieved by "mobile mixed teams" providing punctual, periodic support to a relatively large geographic area. These teams, each composed of at least one technician from MINIPEA and one from IRAD should work exclusively in high priority zones and give priority to assisting effective producer groups in partnership with non-governmental organizations (NGOs) and other outreach agencies as feasible. Besides, they should be complemented by a series of private seed producers, or other service providers, who are also providing technical support to farmers. Thus, the mode of operation of these mobile teams should be one that brings research and extension together and into direct contact with farmers.

The elements of the strategic framework and the role of public and private sectors as well as the specific issues regarding the strategic framework for aquaculture development in Cameroon are given with Appendix 5.

[6] i.e. well trained and well-equipped.

3.5 Conclusions and recommendations: critical constraints and identification of priority action

Following country presentations of the aquaculture development situation within the region (Appendix 6), each representative was requested to name the three major constraints faced by aquaculture. The constraints so identified are shown in Table 1. Analysis and discussion of these constraints led to the identification of three overall priority areas of concern: extension, fingerlings and feeds. Working groups were each assigned one of the three constraints and requested to elucidate in table form, as detailed a plan as possible to address each one.

While these three constraints were identified as important and were the main focus of working group sessions, the workshop acknowledged that there are other, equally or more important, constraints that effect the functioning of the aquaculture sector at a variety of levels. In particular, market development and the adoption of practical policies and the development of efficacious institutions were mentioned as critical.

Of particular note in addressing all constraints to aquaculture is the appearance of a core of persistent and experienced farmers, an important sign of progress that can serve as the foundation for future development. Extension agents are often less knowledgeable than these better farmers. This group may or may not be willing to join in cooperative activities for general social benefits, but their increasing political and economic clout requires that the private sector must somehow be brought into the general aquaculture development planning and extension process. The need to incorporate the private sector is reflected in the financing mechanisms proposed by all three working groups.

Table 1. The top three critical constraints to aquaculture expansion identified by country representatives

Cameroon	**Malawi**	**Ghana**
Fingerlings	Policy	Fingerlings
Extension	Extension	Feed
Feed	Strong institutions	Extension
Kenya	**Zimbabwe**	**Nigeria**
Extension	Credit	Credit
Fingerlings	Extension	Extension
Feed	Strategies	Fingerlings
Uganda	**DR Congo**	**Sierra-Leone**
Extension	Strategies	**-**
Credit	Extension	**-**
Feed formulation	Feed	**-**

Extension

Extension, as defined for the purposes of this workshop, means the entire structure for elucidating, packaging and disseminating information for farmers. As the case study from DRC shows, there is a need for multiple talents within the extension service: data interpretation and analysis, needs assessment, technology adaptation and communication. A number of extension models has been elucidated over the years, the Training and Visit (T&V) system being currently the most widely used. Recently, participatory research and joint learning have come to the fore, but the application of these techniques on a large-scale has not yet been attempted.

The current institutional structure for aquaculture extension is very much top-down with often long chains of bureaucracy linking policy makers, research and technology users. This arrangement results in the loss of much important technical information going from research to farmers, as well as misinterpretation of the needs and constraints of farmers on the part of policy-makers. On the other hand, some progress has been made in terms of clearer job descriptions within the bureaucracy at various levels and more transparent and efficient administration of resources.

In addition to being heavily bureaucratised, the orientation of extension is generally driven by development goals derived with minimal user consultation. Most countries still use a variation of the World Bank T&V approach wherein researchers, attempting to meet national fish production targets, develop technology that seeks primarily to maximize fish production as opposed to meeting the personal development goals of farmers. Research releases its findings in the form of written documentation which is not directly accessible neither by extension agents nor by farmers. The information transmission system is consequently poor both in delivering knowledge of key constraints and development objectives to policy makers, and the delivery of technical information about production systems and markets to farmers. Overall, the achievements of the T&V model in Africa have been negligible in terms of both fish production and numbers of farmers.

High-quality human resources in the field are especially critical to the proper functioning of the T&V system, and this probably accounts for its very low success rate. For an approach such as the T&V system, which is based on adapting technological packages designed by research, field technicians require high levels of training to manipulate flexibly general principles to adjust them to specific on-farm situations. Unfortunately, the time and resources needed to ensure the quality of field staff are lacking in most countries.

Some successes have, however, been reported. Madagascar has decentralized extension by giving private fingerling producers the prime responsibility for technical messages, assuming that improved production will increase demand for fingerlings and, thus, profits fingerling producers. In the DRC, substantial progress has been reported (see Chapter 4.3.) through the use of mobile teams comprised of technical and information transfer specialists. In Malawi and Cameroon, research-extension teams have shown how participatory research can be used to increase technology adoption, even among the poorest user groups.

Contemplating this, the working group attempted to outline a new structure and approach that would incorporate these successes while avoiding the long chains of information transfer characterising less successful approaches. The key element is to concentrate energy on high-potential areas and farmers, hence the simplification of the group output table to just “commercial” farmers (Table 2). Industrial farmers are considered capable to get their own technological advice through in-house research and development or through hiring consultants. The non-commercial sector is encouraged to assume a more commercial orientation.

The main activities designed to overcome the problems facing aquaculture outreach/extension are:

1. High-quality training of extension staff. Such training would be a combination of traditional and on-the-job, joint-learning exercises conducted through the implementation of replicated on-farm trials.
2. A participatory research and extension approach made operational through the best-experienced staff available so as to build confidence among farmers.
3. Mobile research-extension teams to work directly with high-potential farmers.

Fingerling quantity and quality

The importance of seed for aquaculture was realized many years ago and has been the focus of a number of development interventions. Many public-sector hatcheries were built around the continent to address this issue. Unfortunately, poor site selection and/or design, high operating costs of Government stations, low levels of technical expertise and logistical problems in dissemination of seed to farmers led to the failure of most of these efforts.

A shift in public sector support from aquaculture development for its own sake, to aquaculture as a tool in rural poverty alleviation during the 1980s and 1990s led to the encouragement of small-scale, private hatcheries that could be operated in conjunction with extensive or semi-intensive grow-out systems. Although not encumbered with government bureaucracy, small-scale hatcheries are seriously constrained by cash-flow in a chicken-or-egg type of conundrum: There is no market for fingerlings without growth in the production sector. There can be no growth in the production sector without a reliable source of fingerlings. Due to the other constraints facing aquaculture (e.g. inputs and technical assistance), the time lag between growth of production and availability of seed can be several years and most small-scale hatcheries go out of business long before there are enough customers to make them profitable.

Nevertheless, there have been a number of limited successes with small-scale hatchery-led development, most notably in Madagascar, Malawi, Tanzania and, more recently, Cameroon. Where small-scale hatcheries have managed to generate significant incomes for the operators and numbers of fingerlings for other farmers, another problem has been encountered that dilutes impact: deterioration of the genetic quality of cultured populations. Up to 40 percent decline in performance have been reported from the field as a result of poor broodstock management and inadvertent selection.

The working group on fish seed recommended that national governments first seek to quantify the volume and structure (species, users, geography, etc.) of seed demand. In addition, there is a need to alter the prevailing attitude on the part of small-scale farmers that seed should be a free spin-off of pond production, rather than a regular cost factor. Recognizing this, the group maintains that for most of sub-Saharan Africa seed is either not available or if, it is of generally low quality.

The working group identified the lack of trained personnel and missing information dissemination structures as key constraints to ameliorating the seed supply situation. Assistance for all users (non-commercial, commercial, industrial) was basically the same: 1) provide technical and financial support to community-based farmer groups to allow them to produce quality seed for their members; and 2) develop a regional network to share experiences and knowledge (Table 3).

Feeds

Government was seen by the working group on feeds as a key player in the development and assurance of quality in economically viable aquaculture feeds (Table 4). At regional and national levels, inventories and quantitative assessments of supply versus demand of feed materials are seen as a crucial first step in mass production of high-quality fish feeds. Encouraging larger-scale producers by standardizing formulations and helping to ensure quality is another key step. Also important are policy mechanisms that would facilitate trade in feeds and feed materials, such as vitamin and mineral premixes, protein meals, essential oils, amino acids, etc. There were no substantial differences in the approach proposed for government and donors to the commercial and industrial groups, both being merely scales of the same basic type of enterprise.

Assuming that non-commercial farmers will be reluctant to purchase inputs and continue to rely on integrated agriculture-aquaculture technology, there are few short- and medium-term activities that can usefully be undertaken to help this group of farmers apart from the promotion and guidance in use of existing feed/fertilizer materials. The main area of work for this group is to encourage them to become commercial and begin purchasing inputs and selling more of their outputs.

Table 2. Recommended actions, partners and human/financial resources needed to implement practical interventions among commercial user groups at farm, community, national and regional levels to address constraints to the provision of high-quality technology through improved outreach/extension structures

Farmer category	Farm level	Community level	National level	Regional level
Commercial	**Action:** • Engage in joint-learning, participatory research exercises. **Partners:** • Decentralized (local) government • NGOs **Resources:** • Government/ donor funds	**Action:** • Develop local farmer associations to work with research-extension teams. • Conduct joint-learning, participatory research exercises. **Partners:** • International institutions (e.g. FAO/Telefood) • Research/extension services • NGOs **Resources:** • Government/donor funds	**Action:** • High-quality, on-the-job training. • Implementation of participatory research-extension model. • Implementation of mobile, research-extension teams model. • Ensure social, gender, cultural and economic context is well-embedded in the new extension service. • Streamline government service by leasing or selling unnecessary infrastructure. **Partners:** • Research institutions/universities • Commercial hatcheries **Resources:** • Government/donor funds	**Action:** • Promotion of participatory research-extension approaches. • Promotion of mobile, research-extension teams approach. • Information exchange among countries. **Partners:** • International institutions, especially FAO, WorldFish Center, CIRAD, etc. • Donors such as DFID, BMZ, USAID, etc. • NGOs • Financial institutions **Resources:** • National government and donor funds

Abbreviations

CIRAD: Centre of International Cooperation for Agricultural Development Research (France)
DFID: Department for International Development (United Kingdom)
BMZ: Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Germany)
USAID: United States Agency for International Development

Table 3. Recommended actions, partners and human/financial resources needed to implement practical interventions among non-commercial, commercial and industrial user groups at farm, community, national and regional levels to address constraints to the availability of high-quality fish fingerlings

Farmer category	Farm level	Community level	National level	Regional level
Non-commercial		**Action:** • Capacity building at seed producer association level for ensuring seed quantity and quality. **Partners:** • International agencies (e.g. FAO/Telefood) • Decentralized government **Resources:** • Government/donor funds • Trained personnel	**Action:** • Implement sound broodstock management in government hatcheries. • Screen local stocks for best performance. • Training and information dissemination on high-quality seed production technologies. **Partners:** • Research institutions/universities • Commercial hatcheries **Resources:** • Government /donor funds	**Action:** • Information sharing on quality seed technology. • Identify reference centres for training/dissemination. **Partners:** • National/regional/international institutions and projects **Resources:** • A networking mechanism (e.g. NACA*; sustained by countries)
Commercial and industrial	**Action:** • Assist entrepreneurs in preparing sound business plans. **Partners:** • Farmers, associations, NGOs, financial and educational institutions, local government **Resources:** • Business consultants, information services (internet)	**Action:** • Establish the economic viability of seed production. • Capacity building at seed producer association level for ensuring seed quantity and quality. **Partners:** • Farmers, NGOs, extension, financial institutions • International agencies (e.g. FAO/Telefood), local government **Resources:** • Information on markets, inputs, equipment, land/water access and credit • Government /private funds • Trained personnel	**Action:** • Implement sound broodstock management in government hatcheries. • Screen local stocks to identify best genetic material. • Training and information dissemination on high-quality seed production technologies. • Facilitate low-cost financing through commercial finance sector. **Partners:** • Research institutions • Lending institutions **Resources:** • Government/donor funds • Trained personnel	**Action:** • Information sharing on quality seed technology. **Partners:** • National/regional/international institutions and projects **Resources:** • A networking mechanism (e.g. NACA*; sustained by countries)

*Network of Aquaculture Centers in Asia-Pacific

Table 4. Recommended actions, partners and human/financial resources needed to implement practical interventions among non-commercial, commercial and industrial user groups at farm, community, national and regional levels to address constraints to the availability of high-quality fish feeds

Farmer category	Farm level	Community level	National/regional level
Non-commercial	**Action:** • Promote the use and production of suitable pond fertilizers and/or fish feeds. **Partners:** • Extension • NGOs • Farmer Associations **Resources:** • Technical expertise		**Action:** • Encourage non-commercial farmers to become commercial. **Partners:** • Extension • NGOs • Farmer Associations • Donors **Resources:** • Technical expertise • Simple, small-scale financing options
Commercial/ Industrial	**Action:** • Promote the use and production of suitable pond fertilizers and/or fish feeds. **Partners:** • Extension **Resources:** • Technical expertise	**Action:** • Promote production of raw materials. • Facilitate access to land and water. **Partners:** • Farmer associations • NGO • Extension • financial institutions **Resources:** • Technical expertise • Credit	**Action:** • Assess existing and potential demand for feed. • Inventory raw materials for availability and cost, plus potential for sustainable production. • Establish investment and trade friendly environment (e.g. fiscal and other incentives, import substitution policies). • Harmonize fish feed standards in accordance with international standards and market requirements. • Monitor and regulate manufacture of fish feeds. **Partners:** • Regional and international projects/donors **Resources:** • Technical expertise • International and national donor financing

APPENDIX 1: ACRONYMS

BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Germany) (Federal Ministry for Technical Cooperation and Development [Germany])
CGIAR	Consultative Group for International Agricultural Research
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (France) Centre of International Cooperation for Agricultural Development Research [France])
DFID	Department for International Development (United Kingdom)
DoF	Department of Fisheries (Malawi)
DRC/RDC	Democratic Republic of the Congo, République démocratique du Congo
FAO	Food and Agriculture Organization of the United Nations
FHH	Female-headed household
GO	Governmental organization
HIPC	Highly Indebted Poor Countries
IRAD	Institut de recherche agricole pour le développement (Cameroun) (Development Agriculture Research Institute [Cameroon])
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries (Uganda)
MFMR	Ministry of Fisheries and Marine Resources (Sierra-Leone)
MINEPIA	Ministère de l'élevage, des pêches et des industries animales (Cameroun) (Ministry of Livestock, Fisheries and Animal Industries [Cameroon])
NAADS	National Agriculture Advisory System (Uganda)
NACA	Network of Aquaculture Centres in Asia
NGO	Non-governmental organization
PRSP	Poverty Reduction Strategy Paper
SENAQUA	Service Nationale d'Aquaculture (RD Congo) (National Aquaculture Service [DR Congo])
SOWEDA	Southwest Development Agency (African Development Bank)
SSA	Sub-Saharan Africa
T&V	Training & Visit System
USAID	United States Agency for International Development
WRI	Water Research Institute (Ghana)

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APPENDIX 3: AGENDA

DAY 1	Subject	Focal person	Start at
	Registration	Ndindjock	08.30 h
	FAO/WorldFish/CIRAD Joint Planning Meeting	J. Moehl	09.00 h
	Lunch		12.00 h
	Definition of “small-scale” aquaculture	J. Moehl	13.30 h
	Considerations for the introduction of aquaculture	M. Halwart	14.00 h
	Constraints to African aquaculture	J. Moehl	15.00 h
	Break		15.30 h
	History and status of African aquaculture	J. Lazard	16.00 h
	Institutional support to aquaculture	R. Brummett	16.30 h
	Periurban aquaculture in Africa	K. Rana	17.00 h
	Cocktail Reception + Dinner		19.00 h
DAY 2	**Subject**	**Focal person**	
	Aquaculture Extension Review	V. Pouomogne	08.00 h
	Experiences in Kenya	B. Nyandat	08.40 h
	Experiences in Uganda	W. Mwanja	09.00 h
	Experiences in Malawi	S. Chimatiro	09.20 h
	Experiences in Zimbabwe	F. Zimudzi	09.40 h
	Break		10.00 h
	Experiences in DR Congo	G. Kombonzi	10.30 h
	Experiences in Ghana	E.K. Abban	10.50 h
	Experiences in Sierra-Leone	M.F. Sheriff	11.10 h
	Experiences in Nigeria		11.30 h
	Strategic framework for aquaculture development in Cameroon	MINEPIA	12.30 h
	Lunch		13.30 h
	Lessons Learned	B.M. Kalende	14.50 h
	Break		15.30 h
	Identification of working group topics and members	R. Brummett	16.00 h
	Dinner at Etisah Beach		19.00 h
DAY 3	**Subject**	**Focal person**	
	Working Groups		08.30 h
	Break		10.00 h
	Working Groups		11.30 h
	Lunch		12.00 h
	Group Reports		13.30 h
	Break		15.00 h
	Discussion of group reports	J. Moehl	15.30 h
	Dinner at Down Beach Fish Place		19.00 h
DAY 4	**Subject**		
	Elaborate group recommendations on small-scale aquaculture	R. Brummett	08.30 h
	Break		10.00 h
	Discussion of strategies and recommendations	J. Moehl	10.30 h
	Lunch		12.00 h
	Drafting/approval of strategies and recommendations	R. Brummett	13.30 h
	Closing Ceremonies and Adjourn		15.30 h

APPENDIX 4:

DEMOCRATIC REPUBLIC OF THE CONGO / UNITED STATES

PEACE CORPS FAMILY FISH FARMING PROJECT

Mobile teams for aquaculture extension were commissioned and made operational along the following lines:

Composition
There was one mobile team per province with at least three members each (team leader, extension agent(s), aquaculture specialist). The number of extension agents depends on the intensity of work and the number of other actors in the area.

Objectives
1) Develop and/or maintain contact with viable fish farmer associations.
2) Improve the operation of associations.
3) Transfer technology.
4) Improve record keeping among farmers.

Location
Targeted sites were characterized by:

- high population density;
- expressed interest in fish farming, driven by need for food and income;
- perennial sources of water;
- good topography;
- some (limited) history of aquaculture;
- good vegetation cover;
- soils appropriate for pond construction;
- relatively easy access by mobile teams.

Results
The mobile team was especially successful in Bandundu province for the following reasons: 1) high concentration of fish farmers (28 fish farmer associations, 900 fish farmers with an average of 30 farmers/association within a radius of 35 km); 2) high demand for fish; 3) relatively large number of experienced fish farmers (some being able to serve as sources of technical information to others farmers); and 4) easy market access.

APPENDIX 5:
ELEMENTS OF THE STRATEGIC FRAMEWORK FOR CAMEROON

1. Elements of the Strategic Framework and the role of public and private sectors

Sustainable aquaculture development relies on a number of conditions that must be met and addressed in any strategy in a flexible way. The most prominent of these are: 1) suitable production systems; 2) availability and access to inputs (feeds, seed, capital, etc.); 3) outreach; 4) research; 5) education and training; 6) marketing; 7) producer organizations; 8) regulation; as well as 9) control, monitoring and evaluation.

For each of the two types of aquaculture defined in this document (commercial and non-commercial), the following sections define the role of the public[7] and private[8] sectors in meeting each condition. Unless otherwise specified, the role discussed applies to both commercial and non-commercial aquaculture.

In light of limited human and financial resources, government is, in general, shifting and should shift, from its role of a direct investor and development promoter to one of a facilitator of an independent and commercially viable aquaculture subsector. The private sector is composed of two general groups of actors: direct investors, including producers along with service providers, and partners, principally producer organizations and Civil Society organizations.

1.1 Suitable production systems

The government should:

- identify general production technologies appropriate to relevant aquaculture zones;
- inform investors in regard to these technologies; and
- concentrate its outreach activities in these zones.

The private sector should:

- be aware of the government strategy regarding different production systems within aquaculture zones.

1.2 Availability and access to inputs

a) Feeds[9]

The government should:

- stimulate domestic feed industries by reducing or removing taxes on imported feed milling machinery and basic feed ingredients;
- make information on feed and feed materials, especially prices, regularly available to producers through all means of information transmission;
- within its means, ensure feed quality through inspections and feed certification;
- promote the adoption of appropriate feed manufacturing guidelines such as the *FAO Technical Guidelines for Responsible Fisheries* No. 5 Aquaculture Development; and
- encourage commercial farmers and millers to facilitate access to quality feed for the entire subsector.

[7] Includes the ministry in charge of aquaculture, the national research institute and the government extension service.
[8] Includes producers, investors (in both fish farming and related sectors), non-governmental organizations (NGOs), commercial banks, universities and development agencies.
[9] Including commercial and tradable feeds, feed materials and other nutrient inputs.

Direct investors (feed mills) should:

- produce and market necessary feedstuffs to growers;
- provide uniform-quality products at a fair price;
- find mechanisms to facilitate access to high-quality feed throughout the subsector;
- make proximate analyses available to clients;
- provide information on feed availability and efficacy to the public sector;
- as appropriate, assist outreach programmes in promoting good feeding practices/fish management; and
- monitor results.

Producer organizations should:

- serve as a forum for sharing information among stakeholders;
- lobby for collective bargaining and appropriate public sector intervention; and
- link with research organizations.

b) Seed

The government should restrict itself to:

- providing regular information on sources and prices of good-quality seed to producers;
- providing guidelines in producing/ensuring good-quality seed through such measures as seed certification;
- maintaining broodstock of selected culture organisms corresponding to the identified production systems; and
- encourage commercial farmers and hatcheries to facilitate access to quality seed for the entire subsector.

Direct investors (seed producers) should:

- produce and distribute quality seed;
- sell products at a fair price;
- find mechanisms to facilitate access to high-quality seed throughout the subsector;
- as appropriate, assist outreach programmes in promoting good management practices favouring improved yields; and
- monitor results.

Producer organizations should:

- serve as a forum for sharing information among stakeholders;
- lobby for collective bargaining and appropriate public sector intervention; and
- link with research organizations.

c) Capital

Providing and managing credit by the government often leads to conflicts. Thus, in terms of investment capital for commercial aquaculture[10], government should restrict itself to creating an enabling environment, through, for example:

- the provision of information to lending agencies on the profitability of aquaculture[11];
- evaluating the technical merits of investment proposals submitted to lending agencies for funding;

[10] Credit is not generally considered appropriate for non-commercial aquaculture (FAO, 1999).
[11] Relevant information from a variety of sources should be collated by research agencies for this purpose.

- advising farmers on where and how to access funding from specialized institutions; and
- interacting with these funding institutions to negotiate preferential interest rates for aquaculture development, as appropriate.

The private sector:

- In addition to their own equity, commercial producers should rely on private sector funding institutions for capital.
- Lending institutions should consider preferential interest rates for aquaculture enterprises when applicable.
- Investors requesting credit support should prepare clear and precise business plans.
- Formal lending institutions should finance viable aquaculture businesses.
- Small investors should ensure that they have appropriate business and financial management skills before requesting external financial support.

NGOs should:

- work with non-commercial producers to develop financing options;
- collect information on other funding mechanisms and make it available to farmers;
- sensitise farmers to the savings and solidarity funds for use in aquaculture development;
- examine the possibility of creating an aquaculture guarantee fund;
- examine the possibility of providing temporary direct assistance to aquaculture producer organizations.

1.3 Outreach

The government should:

- provide quality technical assistance through an efficient aquaculture outreach programme;
- seek partners as necessary to meet information shortfalls that cannot be met by public resources;
- establish national and international aquaculture information networks which are accessible at local hubs;
- play a co-ordinating role in the outreach programme;
- put emphasis on participatory approaches when providing services to farmers;
- encourage group formation for purposes of rationalising marketing and purchase of inputs, as well as increasing outreach-farmer contact;
- encourage commercial investors to provide outreach support to smaller operators;
- facilitate the creation of discussion channels amongst different aquaculture stakeholders; and
- require larger investors to pay for the technical assistance on a contract basis, negotiated with the institution providing assistance.

The private sector:

- should assist and reinforce public sector outreach programmes, particularly with regard to outreach contributions by feed and/or seed suppliers;
- should evaluate outreach efficacy and advise as to outreach needs;
- should feedback to public sector as to available information sources;
- commercial producers should pay for technical assistance; and
- commercial producers should assess their opportunities for serving as information providers.

1.4 Research

For commercial aquaculture, the government should:

- support applied and farmer-participatory research directed at small- and medium-scale commercial farmers;
- ensure that research is responsive to the needs of farmers[12]; and
- develop methods whereby farmers at the upper limit of the spectrum (i.e. large-scale, capital-intensive systems) have access to government research facilities and scientists on a contract basis.

For non-commercial aquaculture, government should:

- fully fund research for systems operated by low-income farmers.

The private sector should:

- fund research;
- disseminate research results, as appropriate; and
- evaluate research results as input into research agendas.

1.5 Education and training

The government should:

- develop specific curricula for practical training of entry-level farm managers and aquaculture technicians;
- arrange and/or conduct on demand at regular intervals, short courses for in-service training and human resource enhancement;
- establish a continuing training plan for its staff and assist in linking candidates with local, regional or international agencies providing training, education and/or financial assistance, including distance learning options;
- provide information on career development in aquaculture; and
- introduce longer-term, professional training in aquaculture sciences to universities.

The private sector should:

- pay for training of those technicians necessary for the development of a commercial aquaculture sector;
- facilitate training opportunities on their farms; and
- give feedback to the public sector regarding the efficacy of training (materials/curricula, advising on training needs as necessary).

1.6 Marketing

The government should:

- make available information on fish retail prices, conservation and treatment to producers and consumers through newspapers, newsletters, rural radio or other media, for example;
- protect local producers against unfair foreign competition (imports) provided that protective measures used fit within the international trade conventions/agreements;
- provide basic marketing infrastructure, such as roads and communication channels;
- assist producers in promoting aquaculture products (in order to stimulate demand) through agricultural fairs and other such opportunities;

[12] Researchers' merit increases should be linked to on-farm results rather than publication record.

- encourage commercial producers to develop market channels which can be accessed by smaller producers; and
- prepare, publish and regularly monitor guidelines on the implementation of quality standards of aquatic products to protect the public health as well as to improve the acceptability of aquaculture products.

Commercial producers should:

- provide uniform-quality products according to market requirements; and
- look for mechanisms to provide market guarantees for smaller producers (e.g. satellite production systems).

1.7 Producer organizations

The government should:

- promote and facilitate the formation of producer organizations with legal status as appropriate by, for example, advertising their advantages in collective bargaining, streamlining the administrative registration process, etc.; and
- advise interested farmers, feed and seed producers on where and how to obtain assistance in group formation and function.

The private sector:

- Producers should organize themselves to defend their mutual interests, facilitate access to inputs, markets, etc.
- NGOs should play a catalytic role in establishing producer organizations.
- Organizations should consider the establishment of a national producer organization assembling the local organizations.

1.8 Regulation

The government should:

- establish clear and secure user rights to land and water favourable to aquaculture investment;
- avoid unnecessary costs on applicants in acquiring necessary rights to land and water and the right to undertake aquaculture operations;
- regulate the movement of aquatic organisms between watersheds and the provision of discharge and outfall standards (e.g. *Biological Oxygen Demand-BOD* limits or alien species to receiving water bodies, etc.);
- regulate the use of alien and genetically modified aquatic organisms;
- require permits which specify the rights and obligations for commercial aquaculture farmers;
- waive such permits for non-commercial aquaculture as long as government regulatory thresholds are not exceeded;
- adopt an one-stop shop for obtaining permits and information relevant to aquaculture development;
- collect and publish reliable and up-to-date statistics; and
- apply and enforce appropriate international codes to which government subscribes (e.g. *Code of Conduct for Responsible Fisheries – CCRF*);
- determine criteria for requiring environmental impact assessment studies;
- regulate seed production;
- regulate the production of commercial feed production;
- define a regulation on quality control of aquaculture products.

The private sector should:

- be aware of relevant regulations;

- self regulate to ensure good farm management practices with the goal of sustainable resource use;
- self regulate to ensure a safe-to-consume product is provided to all consumers; and
- provide complete and correct data for monitoring by the public sector.

1.9 Control, monitoring and evaluation

The government should:

- control the movement of aquatic organisms between watersheds and the provision of discharge and outfall standards (e.g. *Biological Oxygen Demand-BOD* limits and alien species to receiving water bodies, etc.);
- control the use of alien and genetically modified aquatic organisms;
- for commercial aquaculture farmers, require permits which specify their rights and obligations;
- apply and enforce appropriate international codes to which government subscribes (e.g. *Code of Conduct for Responsible Fisheries – CCRF*);
- define a standard system for statistics/data collection and treatment;
- collect and publish reliable and up-to-date statistics;
- control whether or not, where necessary, environmental impact assessment studies are properly conducted;
- control seed quality;
- control the quality of commercial feeds;
- enforce the regulation on quality control of aquaculture products;
- regularly evaluate the sector development level.

The private sector should:

- respect regulations on the movement of aquatic organisms between watersheds and the provision of discharge and outfall standards;
- respect regulations on the use of alien and genetically modified aquatic organisms;
- seek permits before establishing a commercial aquaculture farm;
- apply appropriate international codes to which the government subscribes;
- regularly provide reliable and up-to-date statistics;
- have self-regulatory, self-control mechanisms to ensure seed quality, the quality of commercial feeds and the quality of aquaculture products.

2. Specific issues

Following the logic and process described above, specific issues regarding the strategic framework for aquaculture development in Cameroon include:

2.1 Government stations

One or more government stations should be maintained for training, fish genetic management and research. The criteria to maintain a station should include, *inter-alia*, its economic viability, the needs for genetic conservation, research and training as well as zones with high aquaculture potential. Following the existing (draft) government master plan for aquaculture, other economically viable government infrastructure should progressively be sold or leased long-term to a well chosen private sector according to existing laws and procedures on the sale or lease of public property. Non-viable infrastructure, or those stations for which no buyer or tenant can be found, can be donated to public institutions such as schools, prisons or orphanages.

Public sector technical services should be able to assist potential buyers or leaseholders in determining the economic potential of these facilities.

2.2 Marine and coastal aquaculture

Mariculture and other coastal production systems are strategically no different from inland systems and the same processes should be applied. However, it should be recalled that coastal regions comprise critical ecosystems which are highly productive though fragile, requiring careful environmental considerations. Also, these areas are complex socio-economic zones where the potential for conflict over use is high and whose economic contribution to livelihoods is highly significant. The existing body of knowledge for best practices for integrated coastal management should be applied.

2.3 Non-conventional aquaculture systems

The culture of ornamental species should, as well, be considered among the multiple aquaculture systems practised in the country. Organically certified aquaculture, growing aquatic plants, etc. are also examples of non-conventional systems.

2.4 Unexplored culture species, introductions and genetically modified organisms

Mainstream aquaculture species are tilapias, catfish, carp and *Heterotis* along with a few minor cichlids. The establishment of presently unexplored culture species may have high economic costs for the development of the required seed multiplication and distribution networks. Thus, the promotion of new culture organisms must take these costs into consideration.

Introductions of alien species need to adhere to international conventions and covenants.

Control of genetic integrity of aquatic organisms is an important issue, which is frequently addressed under the rubric of aquaculture. Reference has been made above to precautionary procedures that are advised, however, is it noteworthy that the overall pond management needs to be significantly enhanced before any benefits of genetically modified organisms can become apparent.

APPENDIX 6:

SUMMARIES OF COUNTRY PRESENTATIONS

PRATIQUE DE L'AQUACULTURE EN RÉPUBLIQUE DÉMOCRATIQUE DU CONGO (RDC)

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Les premiers essais de la pratique de l'aquaculture en RDC se situent dans les années 1940 et 1945 par le colonisateur belge. Les poissons de la province du Katanga à Kasenga furent alors les premiers à servir d'expérimentation après capture pour l'élevage de poissons d'eau douce dit pisciculture en Afrique. Ces poissons tilapia ainsi capturés au Katanga furent la base à l'éclosion de l'activité piscicole en Afrique tropicale.

Quelques années plus tard, à l'accession du pays à l'indépendance, alors que la population nationale atteignait à peine 15 millions d'habitants, le colonisateur avait installé 45 Centres d'alevinage principaux et secondaires capables de produire 10 000 tonnes d'alevins par an pour desservir près de 15 000 pisciculteurs propriétaires de plus de 126 100 étangs couvrant ensemble une superficie d' environ 9 000 ha d'étangs noyés.

Après l'indépendance du pays en 1960, la situation politico-économique de la RDC à l'époque fit que la plupart de centres d'alevinage ci dessus évoqués soient abandonnés ou mal exploités et la production moyenne à l'époque qui était de 0,45 tonne/ha/an de poisson chuta brusquement à moins de 0,035 tonne/ha/an. Cette chute de production trouve son origine dans :

1. le départ précipité et sans transition du personnel d'encadrement belge ;
2. l'inexpérience et/ou l'insuffisance de l'expertise locale en la matière ;
3. les différents mouvements de guerre et rebellions.

Dix ans plus tard, vers les années 1970, plusieurs projets implantés de manière ponctuelle et financée par les différentes coopérations bilatérales tentèrent de redémarrer l'activité piscicole en RDC longtemps en veilleuse:

- La Coopération française dans l'hinterland de Kinshasa, la Capitale, qui a réussi à encadrer 200 pisciculteurs autour de 10 ha d'étangs pour une production de 250 000 alevins de tilapia par an et 20 à 60 tonnes de poissons marchands.
- L'USAID et les Corps de la Paix qui ont couvert six provinces du pays sur les 11 qu'il regorge. Le Corps de la Paix ont encadré 2 029 pisciculteurs disposant de 3 229 étangs sur une superficie de 81,03 ha. La production variait entre 1 500 à 1 800 tonnes de poissons marchands par an
- La Coopération technique belge, elle, a travaillé sur trois provinces pour l'encadrement de 526 pisciculteurs, propriétaires de 1 603 étangs couvrant ensemble 77,6 ha d'étangs pour une production moyenne de 600 tonnes de poissons marchands par an.

En 1990, à la suite des événements de la démocratisation et troubles politiques divers, toutes les coopérations ci-dessus mentionnées firent fermer avec l'embargo et l'isolement politico-économique qu'a subit le pays pendant 10 ans.

Il y a lieu de remarquer que l'activité piscicole en RDC était pendant un certain temps, après l'indépendance du pays, sous la conduite et l'apanage de différentes coopérations bilatérales. Chaque projet avait donc sa méthodologie de travail et son approche bien appropriée poursuivant malheureusement le même objectif global qui est la réduction de la pauvreté, la sécurité alimentaire et l'amélioration du revenu du paysan pisciculteur. Tous ses projets prônaient à la fois la pisciculture familiale de subsistance, la pisciculture sémi-intensive et envisageaient également la pisciculture associée à l'élevage d'animaux

à cycle court de reproduction (porc, volaille). Cela sur fonds d'approches différentes. Cette situation n'était pas de nature à faciliter la tâche au Gouvernement dans la mesure où il assistait impuissant devant cette disparité de responsabilité sans une politique nationale cohérente en la matière.

Ainsi donc au regard de cette impasse, il est aujourd'hui crée en RDC un Service National d'Aquaculture ayant pour rôle principal l'encadrement, la planification et la promotion de l'aquaculture dans son sens premier vers un développement durable en conformité avec l'évolution mondiale de la matière. Pour y arriver la RDC envisage, très prochainement, de mettre sur pied un cadre juridique ainsi qu'un Plan Directeur de Opérations avec l'appui de la FAO.

Table 1. Situation de la pisciculture en RDC par province et par centre d'alevinage (Juin 1990)

Provinces	Bas-congo		Bdd		Kasaï Or.	Kasaï Occ.	Kasaï Occ.	Equat.	P. Or	Sud Kivu	Nord Kivu	TOTAL
Centre d'alevinage	Kasan-gulu	Mawu-nzi	Nzinda	Kianza	Nganda-jika	Katwi-shi	Dibaya	Geme-na	Wa-mba	Nyan-gara	Lu-bero	-------
Nombre d'étangs	11	47	15	42	55	14	18	39	20	45	6	367
Superficie totale (ha)	1,33	4,6	0,9	10	2,55	0,50	0,47	2,6	5,05	2,5	2,3	33,92
Capacité de production	7,98	27,60	3,14	60	15,30	3	2,87	15,6	30	15	12,8	203
Niveau d'exploitation	40%	0%	0%	30%	30%	30%	20%	0%	0%	30%	0%	-------

Généralités, potentialités et quelques réalisations

La RDC dispose d'une potentialité piscicole étalée sur 2 400 000 km² repartis comme ci-après: 1 600 000 km² pour la pisciculture de subsistance en campagne 800 000 km² principalement autour des grandes agglomérations disponibles à la pisciculture intensive, durable et commerciale. En plus 64,2 pour cent de la superficie totale de bassin du fleuve Congo traversent le territoire national, offrant ainsi au pays d'énormes potentialités d'implantation et d'exploitation aquacole dans toutes les vallées et bas-fonds des montagnes et collines non recensées jusqu'à nos jours.

Plusieurs milliers de ruisseaux dont les débits varient entre 5 et 60 litres par seconde traversent des vastes vallées et ne tarissent point pendant la saison sèche. Le pH de toutes ces eaux varie entre 5 et 7,5, tandis que la température moyenne est de 24 °C avec une solubilité moyenne d'oxygène de 8,41 mg/litre. Du point de vue capacité biogénétique, les eaux congolaises sont d'une richesse remarquable (présence de phytoplanctons et zooplanctons).

Les poissons d'élevage en RDC sont: *Oreochromis niloticus, Tilapia macrochir, Heterotis niloticus* et *Clarias gariepinus.* L'aquaculture congolaise repose essentiellement sur la pisciculture de subsistance avec prédominance de la culture de tilapia malgré d'énormes possibilités d'élevage d'autres espèces notamment: les crevettes, les mollusques les grenouilles, les crocodiles, l'azola et autres plantes aquatiques.

L'élevage de *Clarias* est une introduction récente dans l'Hinterland de Kinshasa et dans la vallée de Mbankana dans la Province de Bandundu. Pratiquée par insémination artificielle, cette technique se développe rapidement au regard du résultat très intéressant de croissance et gain de poids de l'espèce.

Dans la vallée de la FUNA (Hinterland de Kinshasa) le sujet atteint 3 à 5 kg par cycle de production de 6 mois d'élevage semi-intensive. Dans la vallée de Mbankana, avec les mêmes conditions d'élevage presque, le sujet atteint également 4 à 6,5 kg. Dans les deux cas le taux de survie par éclosion varie de 28 à 30 pour cent d'alevins.

La culture de tilapia par contre cette pratique avec extension sur toute l'étendue de la République. La méthode culturale pratiquée actuellement est celle dite «mixte», aux sujets non sexés et de différents âges. Cette méthode conduit souvent au phénomène de nanisme dans la plupart d'exploitations des milieux ruraux. Les poissons tilapia non nourri de manière régulière en RDC atteint difficile 150 g après 6 mois d'élevage.

Pour résoudre ce problème nous avons amorcé le monosexage qui consiste à séparer les mâles de femelles dans notre centre de formation et de vulgarisation de Kansangulu à 45 km de la Capitale Kinshasa. L'exercice est en cours.

Comme on le remarquer les contraintes au développement de l'aquaculture en RDC sont de plusieurs ordres, notamment:

1. L'absence d'une politique et d'une stratégie cohérente du gouvernement en matière du développement durable du secteur aquacole
2. Le délabrement des infrastructures de base (45 Centres d'alevinage principaux et secondaires)
3. L'insuffisance des cadres techniques formés et de capacités institutionnelles de la structure en charge de vulgarisation et encadrement technique,
4. Difficultés d'acquisition et indisponibilité des intrants (alevins de bonne souche, aliments et matériels divers)

Table 2. Taux d'encadrement de pisciculteurs par le SENAQUA en RDC.

PROVINCES	Effectifs de pisciculteurs	Nombre des étangs	Superficie totale recensée (ha)	Production escomptée (tonnes)
1. Bas-Congo	226	197	3,82	136,045
2. Bandundu	1 003	1 660	32,32	13,370
3. Kasaï oriental	169	294	14,00	113,12
4. Kasaï occidental	503	807	9,96	4,90
5. Nord Kivu	103	327	4,70	34,860
6. Sud Kivu	79	105	1,78	6,63
7. Katanga	402	439	6,20	16,45
8. Equateur	206	394	7,64	21,700
9. Province orientale	216	462	8,73	26,740
10. Maniema	109	208	5,32	30,555
11. Kinshasa	1 602	7 479	38,87	18,620
TOTAL	4 618	12 372	103,34	422,045

AQUACULTURE STATUS, CONSTRAINTS AND PRIORITIES FOR DEVELOPMENT IN GHANA

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In Ghana, the concept of culturing fish became popular during the early 1970s, primarily as a "back-yard" farming activity. Commercial aquaculture gradually evolved during the late 1970s and early 1980s. For a variety of reasons, these early efforts generally failed to achieve economic sustainability. Since 1993, enthusiasm in fish culture has revived and aquaculture is now widely practiced throughout Ghana with concentrations in three of the ten administrative regions of the country.

Virtually all aquaculture in Ghana is conducted in earthen ponds. Operations are small both in number and size of ponds per farmer. For example, in one of the major regions of aquaculture, farms are comprised of one to six ponds of between 50 and 10 000 m².

Total production from ponds from 1998 to 2002 is shown in Table 1 and is insignificant in relation to the gap between capture production and fish demand (Table 1). Individual farmer production is estimated at one to two tonnes/ha/year suggesting a very low level of farming activity. Major constraints and their significance to development are outlined below, along with suggestions to improve the current situation.

Table 1. Production against estimated fish consumption and net imports (tonnes) Ghana (Directorate of Fisheries)

Year	**1998**	**1999**	**2000**	**2001**	**2002**
Fish Requirement	736 000	754 000	772 000	792 000	803 000
Marine Production	376 362	332 641	380 000	355 000	290 000
Inland Production	76 300	89 400	87 500	88 000	88 000
Pond Production	1 800	2 900	7 500	6 000	6 000
Net Fish Imports	283 000	332 000	308 000	338 259	430 000

Priority areas for action

Culture systems
The general public considers that fish culture can take place only in ponds, limiting participation. Farmers in savannah parts of country where water availability is restricted to reservoirs could, if properly supported by research and extension, undertake ranching, cage and stock enhanced aquaculture. Coastal lagoons are another area with substantial room for expansion, if technology were available. Appropriate education at various levels, along with pilot projects involving farming and fishing communities, could serve to mitigate this constraint.

Fish species for culture
The aquaculture sector in Ghana is based on only two species of fish: the Nile tilapia, *Oreochromis niloticus* and the African catfish, *Clarias gariepinus.* This low variability in fish culture products, adversely influences marketing of products and reduces the options to take advantage of new aquaculture sites and technology. Identification and evaluation of culture performance evaluation of the many suitable indigenous species could increase the diversity and stability of aquaculture. Investments should be made in expanding the range of fish culture products and to create specialty products for the market. The freshwater fish fauna of Ghana includes at least five species, which may not need special efforts to be cultured by farmers. Participatory research on culture performance could stimulate interest among farmers in these new species as culture candidates.

Development of improved strains
Although only two fishes have been principally cultured in Ghana and Africa, the populations currently cultured are wild or almost so. The situation limits predictability of response of fish in culture to management regimes and thus productivity. There is the need to invest in national fish breeding programmes to generate domesticated breeds for culture. This would also serve to enhance production of certified fish seed from hatcheries and thus the growth of this important subsector.

Fish seed quality and quantity
There is no regular or reliable source of fish seed, making it difficult to plan production, and limiting the adoption and expansion of (especially) small-scale commercial production systems. Culture facilities are consequently underutilized and programmed production and predetermined product size is constrained, leading to difficulties in marketing. It is necessary to have fry production establishments as enterprises in themselves to ensure maximum cycles of production. Properly managed, hatcheries could also protect genetic diversity and limit inbreeding and its effect on production. Education on the merits of obtaining high-quality fish seed from certified hatcheries could help to overcome this problem. Appropriate training and the provision of credit facilities to intended hatchery operators would further improve the quality of the cultured stock.

Commercial fish feeds
Manufactured aquaculture diets are not available in the Ghanaian market. The lack of reliable feeds limits and complicates production programming on the majority of farms even where financial resources for obtaining feed exists. Lack of feed also limits the optimum utilization of culture facilities because of the necessity to stock below maximum capacity. In addition to alleviating these constraints, the manufacturing of feeds would create employment opportunities at both rural and urban areas. Emphasis on formulating feeds from local agro-industrial by-products could improve the economics of utilization of agricultural by-products. Investment into research on formulations and trial of feeds should be accompanied by support to industry to initiate production of fish feed.

Institutional arrangement
The current institutional arrangement for support to aquaculture constrains growth by limiting the government's ability to:

- make maximum use of scarce resources for aquaculture development;
- focus the aquaculture agenda in regard to training, extension and research;
- avoid conflicting legislation emanating from the institutions charged with contributing to aquaculture development.

To ameliorate this situation, it is necessary to establish clear information networking structures and coordinate the major institutions involved in aquaculture development. A streamlined and efficacious institutional arrangement for support to aquaculture would include policy, planning and evaluation, education and training, research and development as well as extension. Such a networked national institution would then be in a position to be useful to aquaculture practitioners and entrepreneurs.

AQUACULTURE MANAGEMENT AND DEVELOPMENT IN KENYA

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Aquaculture in Kenya has the potential to significantly contribute to the national economy through employment creation, foreign exchange earnings, poverty reduction and food security. The new Ministry of Livestock and Fisheries Development, is therefore taking steps to facilitate aquaculture development, including intensive training of extension workers and fish farmers, applied research and appropriate transfer of technology through efficient extension services. Aquaculture has not been given much attention in the past, and growth has consequently been very slow. With the new focus and new approach to delivery of extension service, fish farming as a business is expected to achieve new heights.

Kenya is endowed with numerous resources with potential for aquaculture. The Indian Ocean coastline, Lake Victoria, several large rivers, swamps and other wetlands could support aquaculture. Environments range from marine and brackish water to warm and cold freshwater. Having privatized livestock production and veterinary services, the government's main focus is on extension services, appropriate technology and improved management. It is against this background that aquaculture, with a potential and good rate of return on investment has to be demonstrated and introduced. It is not surprising that many in Kenya still look at fish farming as a marginal and risky investment.

Aquaculture in Kenya is similar to many countries in Africa, characterized by low levels of pond production stagnating over the past decade. Although rural fish farming in Kenya dates back to the 1920s, it was only popularized in the 1960s through the "Eat More Fish" campaign. However, no spectacular progress has been achieved in this subsector since its initiation. Current national development strategies focus on alleviating poverty, increasing food production and ensuring environmental health. The major emphasis of the national food policy is not only to provide carbohydrate-rich staples, but also provide quality protein. Thus, a policy priority is to improve or introduce alternative sustainable low-cost family and community initiatives, which will increase protein available for domestic use and also generate income and reduce poverty. One such initiative is to support aquaculture. Kenya has a good base on which to expand its aquaculture output. Several possible activities include: foodfish culture, shellfish for export, seaweed, sport fishing enhancement, ornamentals for export, recycling of organic wastes and the production of industrial fish products such as fish meal and fertilizers.

Current status and potential

Aquaculture contributes only about 0.5 percent of total national fish production (Table 1). Approximately 1 000 tonnes are harvested from some 10 400 small ponds owned by about 7 500 fish farmers. About 95 percent of fish farming in Kenya is small-scale. The current mean yield from small-scale fish farming is 1 000 kg/ha/year. The production statistics may not be accurate because of poor data collection. Most farmers do not keep records of harvests or sales and do not inform the extension services when they are harvesting. It is important to conduct a survey to ascertain the current number of farmers, ponds and production in the country. Inconsistent data not withstanding, aquaculture has enormous growth potential with only about 0.014 percent of the 1.4 million hectares of potential sites currently under aquaculture.

Table 1. Trends in fish production (tonnes) and the contribution of aquaculture (1980-2002)			
Year	Total Fish Production	Aquaculture Production	Aquaculture (% of total)
1980	48 218	596	1.24
1981	57 372	421	0.73
1982	81 133	440	0.54
1983	97 461	585	0.60
1984	90 796	711	0.73
1985	105 973	1 085	1.02
1986	119 978	980	0.82
1987	131 181	1 094	0.83
1988	138 132	1 149	0.83
1989	146 403	922	0.63
1990	201 778	973	0.48
1991	198 637	1 009	0.51
1992	163 139	1 017	0.62
1993	183 091	1 014	0.55
1994	202 890	1 119	0.55
1995	193 789	1 083	0.56
1996	181 084	970	0.54
1997	164 044	1 002	0.61
1998	172 665	994	0.58
1999	214 712	984	0.46
2000	202 639	967	0.47
2001	164 261	998	0.61
2002	128 227	962	0.75

Table 1 shows that aquaculture production has not been rising in recent years. Improving aquaculture, however, requires significant input from those institutions responsible for developing and implementing formal and informal education and research programmes. Well-trained managers and stakeholders are necessary if resources are to be used on a productive and sustainable basis. The competitiveness and profitability of the aquaculture industry will be directly related to financial inputs, investment in research, extension and database development.

The varied climate and geographic regions of Kenya favours a variety of fish species that can be utilized for aquaculture: The indigenous tilapias are preferred by consumers and are the most commonly cultured fishes, especially *Oreochromis niloticus* and *Tilapia zillii* quite often in polyculture with the African catfish (*Clarias gariepinus*). Exotic species were introduced in the early part of last century and are represented by the common carp (*Cyprinus carpio*), rainbow trout (*Onchorynchus mykiss*), largemouth bass (*Micropterus salmoides*), red swamp crayfish (*Procambarus clarkii*) and more recently gold fish (*Carrassius auratus*).

Trout farming

Rainbow and brown trout were introduced in 1910 and 1921, respectively. The primary goal for the introduction of trout was to provide fingerlings to stock cold-water rivers for angling. A government hatchery facility was constructed to hold eggs and fingerlings before their release into rivers. Attempts to breed these species are thought to have initiated the earliest forms of aquaculture in the country. Trout farming is currently confined to a few commercial fish farms. Despite great potential, trout farming has not expanded due to the inefficiency of the government trout hatchery in Central Kenya. The government has recognized the role trout farming could play in poverty reduction through employment creation and has embarked on rehabilitating the existing hatcheries and establishing new ones. It is envisaged that these hatcheries will encourage trout farmers and also support stocking of trout rivers for promotion of angling tourism.

Mariculture

Introduction of mariculture in Kenya dates back to the early 1980s. Despite 400 km of suitable coastline, mariculture is yet to develop as an important economic activity in Kenya. Shrimp (*Penaeus* spp.) farming has been attempted at Ngomeni, North of Malindi. Oysters and seaweeds (*Euchema* spp.) are cultured on a small scale, mainly within the reefs and creeks, using semi-intensive, inter-tidal technology. The government is currently looking into prospects of private/public partnerships in developing shrimp farms along the coast. A project concept by a private entrepreneur for over 800 hectares is in the final design stages.

Research and training

Research and training is based at the Sagana Fish Culture Farm, the largest of its kind in East Africa. Established in 1948, Sagana occupies some 51 hectares of land with about 25 hectares under water. The production technology is primarily based on integrated agriculture-aquaculture, making it very attractive to a range of users, including the poor. The farm serves as a research centre, a training facility for fisheries personnel and fish farmers, demonstration farm and fingerling supply centre. Based at Sagana, the Department of Fisheries has been working closely with both local and international universities to promote aquaculture development in Kenya and the region with remarkable achievements in the short term. The Pond Dynamics/Aquaculture Collaborative Research Support Program of USAID (PD/A-CRSP) began working at Sagana in 1996 and has greatly assisted the department in viewing aquaculture as an enterprise. Both, the research and the training and extension programme, have demonstrated that fish farming can be undertaken as a very profitable business. Farmers who participated in participatory research trials organized by Sagana and PD/A-CRSP have increased their production by 5 to 10 times.

Aquaculture extension

In recognition of the importance of aquaculture as an income generating activity, the Department of Fisheries has embarked on strategies aimed at facilitating aquaculture development through efficient service delivery. The major departure from the conventional extension service is the use of contact farmers and field days to demonstrate and promote aquaculture, especially small-scale, as a business activity. Some of these new strategies include:

- staff and community training;
- rehabilitation of departmental fish farming demonstration centres and research stations to bring extension closer to existing and potential farmers;
- development of quality extension packages for extension workers;
- enhanced research on seed and feed production;
- involvement of communities in utilizing public dams and reservoirs for cage farming;
- promotion of trout farming and angling in cold rivers;
- promotion of semi-intensive shrimp culture through private/public partnerships to create employment opportunities for coastal people;
- promotion of community participation in fish farming extension through on-farm trials and field days for farmers and extension workers;
- use of aquaculture for stock enhancement in Lakes Naivasha and Victoria;
- facilitation of optimal utilization of water for aquaculture and participation in watershed studies, restoration and management;
- modernization of Sagana Fish Culture Farm as a regional Centre of Excellence;
- linking farmers to existing rural finance institutions.

Major constraints

Although Kenya enjoys a long history of aquaculture and the country is endowed with the natural resources necessary for significant aquaculture growth, the subsector has lagged behind in its contribution to the country's economy. Various constraints have caused the slow development of aquaculture in Kenya, including:

Inefficient research and extension
Inadequate extension facilities, poorly managed government hatcheries and research stations as well as undertrained extension personnel have slowed the growth of aquaculture in Kenya. The Sagana Fish Farm is ideal for aquaculture training, but lacks adequate facilities such as accommodation and lecture halls. Aquaculture has not been taken seriously and therefore, fisheries research institutions and universities have not conducted any meaningful aquaculture research.

Lack of good quality seed
Production of fingerlings has been a monopoly of the government but has not been efficient because of poor funding and low technology.

Lack of feeds
Although affordable and cost-effective feeds are recognized as necessary for enhanced production of farmed fish, manufactured diets are not readily available in Kenya.

Lack of a fisheries policy
Kenya's economy is agriculture-based and the government has tended to put emphasis on crops and livestock production. Fish farming has thus to compete with agriculture and other sectors for land and water. There is a need to develop policies that integrate aquaculture into agricultural systems and highlight the complementary role of fish in meeting social and economic development targets.

Poor data
Aquaculture statistics collection has been poor, limiting the data available to support funding initiatives within government and among international donors.

Summary and conclusions

The government realizes that aquaculture can play an important role in poverty reduction, provision of protein food and reduction of fishing pressure in the natural ecosystems. The Department of Fisheries has therefore embarked on various strategies aimed at facilitating commercialization of small-scale fish farming. These include staff and community training, rehabilitation of fisheries research stations, enhanced research collaboration and development of extension packages.

During the preparation of the Poverty Reduction Strategy Paper in 2000, the government identified aquaculture development as a core activity for funding through the current Medium-Term Expenditure Framework budgeting system and we expect more funds to promote aquaculture. Following this development and the reorganization of government, aquaculture is now one of the four core functions of the Fisheries Department and will henceforth aim to overtake capture fisheries in production.

It is apparent that small-scale fish farming in Kenya could be developed into a viable enterprise, capable of supporting economic activities in rural Kenya and contributing to the Kenya Rural Development Strategy. This potential can be realized in the medium term if the government partners work together to build capacity for an organized extension service.

STATUS OF AQUACULTURE DEVELOPMENT POLICY IN MALAWI: WHAT IS THE FUTURE?

Sloans Chimatiro
Department of Fisheries

The mission of the Malawi Department of Fisheries is: “To provide framework conditions and excellent services for the maximization of socio-economic benefits through sustainable utilization and management of capture fisheries and increased aquaculture production.” Within this broad framework, the goal of the department is: “To provide professional services to ensure sustainable fisheries resource utilization and enhanced aquaculture through principles of good governance.” To make this goal operational, the department seeks to:

- manage all fisheries according to operational management procedures;
- restructure, reorganize and strengthen the Department of Fisheries for effective internal, national and international communication;
- strengthen user institutional capacity for fisheries resource management and governance;
- update legislation and policy in line with other national policies and legal instruments.To achieve these goals, the department undertakes to: 1) generate scientific information to guide management; 2) disseminate the results of research and development; 3) foster greater community involvement in resources management; 4) develop the institutional capacity of the Fisheries Sector; 5) generally promote small- and large-scale fish farming and 6) adopt responsible fisheries and aquaculture (e.g. prohibition of exotic fish species).

While having substantial water resources and potential for aquaculture, the fish farming sector in Malawi remains dominated by small-scale, integrated farming systems that produce many local benefits, but few macro-level impacts on the economy or overall food security. The main constraints identified to the generation of a more commercial sector are:

- unclear legal and legislative provisions to support development of fish farming;
- lack of, or weak, farmer institutions;
- no formal link between government/NGO or service providers and farmers;
- poor knowledge of fish farming technologies;
- fish farming not integrated into the district decentralization structure;
- lack of community support;
- poor resource base at farm level;
- lack of “appropriate technologies”.

The policy strongly supports poverty reduction by undertaking appropriate fisheries and aquaculture regulatory and management measures, while promoting sustainable, responsible and optimal utilization and management of the national fisheries and aquaculture resources. By contributing to the four pillars of the Malawi Poverty Reduction Strategy Paper (PRSP) the department hopes to:

- promote rapid and sustainable pro-poor economic growth and structural transformation;
- enhance human capital development;
- improve the quality of life of the most vulnerable;
- promote good governance; and ultimately
- to increase and sustain fish production from smallholder and large fish farming operations in order to improve fish supply. The development and implementation of this strategy has been evolving over recent years. To date, the department has succeeded in defining the scope for development at two levels: small- and large-scale,

defining a development strategy based on low input, on-farm available resources, conducting research to identify critical development recommendations, producing a "Technical Toolbox" in the form of an "Info-Kit", developing a generic "Legal Toolbox", aligning aquaculture development with national and global issues and developing a management agreement with the Fish Farmer Association.

Strategic Development Plan under Poverty Reduction Strategy Paper

A number of key areas for specific and directed action have been spelled out under the fisheries part of the PRSP:

- increase number of fish farmers to 5 000;
- increase production from 500 to 1 000 tonnes/ha/year;
- provide adequate knowledge to fish farmers;
- improve the knowledge and capacity of extension staff;
- improve capital outlay of poor-resource rural fish farming;
- improve participation of female farmers, esp. female-headed households (FHH);
- improve the status of seed/fingerlings in the country;
- improve growth of indigenous fish species on small-scale fish farm;
- develop scope for use of exotic species.

In particular, the department would like to increase culture of the indigenous Chambo (*Oreochromis karongae*, *inter alia*) from basically 0 up to 1 500 in pond culture by 2010 and thence to 5 000 tonnes/year through cage culture in Lake Malawi and elsewhere. In realizing these goals, the department understands that there are many outstanding issues that need resolution, in particular the following key questions need answers:

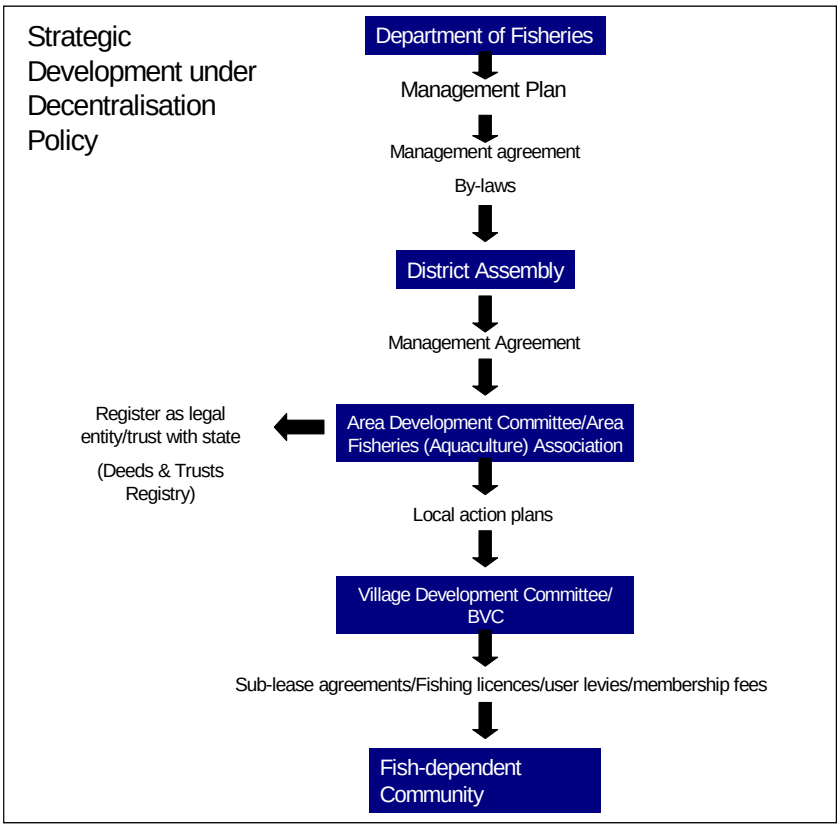
- What is the role of Fish in Food Security and Nutrition?
- What is the replacement cost of low local production?
- What role can fishpond play in crop/livestock production?
- What is the role of fish in HIV/AIDS mitigation measures?
- How are fish-dependent communities affected by the pandemic?
- How do we mainstream gender issues in fish farming development?
- How do we adapt fish farming to the needs of women and FHH?
- What role is appropriate for the youth?

To deal with these questions, the department has restructured both its physical arrangement and also its ideological and operational orientation (see Figure on next page).

In the process of imagining and implementing these changes, the department has succeeded in gaining considerable knowledge of how and why aquaculture grows and how it interacts with policy at both macro and micro levels. Key findings include:

- Fish farming is no panacea for replacing the collapse of natural fish stocks.
- There is a need to build capacity for decision and policy making.
- We need to establish entry points for aquaculture by developing a system which makes sense ecologically, farming system-wise, economically.
- Fish farming should be adapted to relevant national policies.
- Capacity is lacking at the farm level.
- Delivery/outreach systems or mechanisms are weak.
- We need appropriate legal/legislative mechanisms (i.e. policy, strategic plan, legal toolbox).Lobby/advocacy is lacking among both, government organizations and NGOs.
- We should show successful stories (this requires good planning and adaptive management).
- We should always be open-minded and learn from mistakes.

- We must be aware of the driving force behind aquaculture (i.e. technology, economic, food security needs, etc.).



The way forward

The future of aquaculture in Malawi will depend not only on the Department of Fisheries (DoF) but also upon a range of partners and stakeholders. To ensure ownership (and partnership) of the process at all levels (producers, national, international institutions) we will need to prioritize what is doable to ensure optimum delivery for success. New

ideas (not business-as-usual talk-shows), innovations and imagination will be required and channelled through new leadership arrangements based on communication, inspiration, integrity, focus and an output-oriented frame of mind. Ultimately, the sustainability of aquaculture in Malawi depends on:

- political will (which we abundantly have);
- enhancement of technical and managerial skills (both in DoF and farmers);
- adequate human, technical and financial resources;
- need to encompass global and national agendas;
- partnership with national and international agencies;
- need for research and scientific development.

AQUACULTURE IN NIGERIA: HISTORY, STATUS AND PROSPECTS

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The case for aquaculture in Nigeria, with a human population of over 100 million, extensive freshwater, brackish water and marine sites that could be exploited profitably for aquaculture production, is compelling. At present, Nigerian aquaculture is predominantly an extensive land-based system practised at subsistence levels in freshwater. Commercial aquaculture is yet to become widespread or popular. Only recently, the coastal region has become a focus of development. This paper presents an overview of aquaculture in Nigeria and examines its status, prospects and constraints to its development as a step towards using aquaculture as a tool for enhancing national food security through improved protein nutrition.

History of aquaculture in Nigeria

Artisanal fishermen and fishing communities in Nigeria have practised traditional methods of fish culture in tidal pools and floodplains for generations. These were extensive polyculture systems, which do not fall strictly under the modern definition of fish culture, that is "production under controlled conditions", and presently they do not play any significant role in the national economy. The first attempt at fish farming was in 1951 at a small experimental station in Onikan (Lagos State) culturing *Tilapia* species. Following disappointing results with tilapias, modern pond culture started with the establishment of a pilot fish farm (20 ha) in Panyam (Plateau State) for rearing the common/mirror carp, *Cyprinus carpio*. These trials generated sufficient interest to encourage regional governments to establish more fish farms.

At present, most Nigerian fish farmers operate small-scale farms, ranging from homestead concrete ponds (25–40 m^2) operated by an individual farmer or family to small earthen ponds (0.02–0.2 ha) operated as part-time or off-season occupations by communities, institutions, associations or cooperative societies. In 1990, there were over 6 000 homestead concrete ponds, about 6 000 small earthen ponds and 100 commercial farms (>3 ha) in operation. Although the available water surface suitable for aquaculture has been estimated at 483 406 ha, the total area of production units is 5 000 ha. Both indigenous and introduced species are cultivated in ponds, reservoirs and cages. Tilapias (*Oreochromis, Sarotherodon, Tilapia* spp.), clariid catfishes (*Clarias* and *Heterobranchus* spp. and their reciprocal hybrids) and the common/mirror carp (*Cyprinus carpio*) are the most widely cultured fish in Nigeria, because of their fast growth rate, efficient use of natural aquatic foods, omnivorous food habits, resistance to disease and handling, ease of reproduction in captivity and tolerance to wide ranges of environmental conditions. The introduced carp is particularly suited to the middle belt and southwest zones of the country.

Present status of aquaculture in Nigeria

According to the FAO, Nigeria's aquaculture industry produced over 30 000 tonnes of fish in 2000 (Table 1), mostly tilapias and catfishes, cultivated under intensive (commercial) and semi-intensive (artisanal) production systems. Despite this status, the potential for aquaculture is below optimum when compared with its potential, both biophysical and socio-economic. Nigeria has a coastline of about 960 km bordering an extensive mangrove ecosystem comprising lagoons, estuaries, wetlands and series of interconnecting creeks. The coastal zone covers an estimated 1 million hectares and offers considerable potential for commercial aquaculture. About 600 000 km^2 and 400 000 km^2 of potential land area for subsistence and commercial aquaculture,

respectively, have been identified in all geographical zones of Nigeria, hence lack of suitable sites is not a constraint to aquaculture development. By and large, aquaculture development is government-driven, however, considerable involvement of the private sector has been reported. Despite these efforts and depressing statistics, aquaculture in Nigeria can be described as fairly well developed. The challenge to Nigeria, at this time, is to ensure that aquaculture takes its rightful place in the forefront of fish production to ensure national food security in the coming years.

Table 1. Nigerian aquaculture production in 2000, including culture-based fisheries in coastal and inland waters

Species	Tonnes
Tilapias (*Oreochromis niloticus, O. niloticus* x *O. aureus* hybrids)	11 363
(*Sarotherodon melanotheron, Tilapia zillii, T. guineensis*)	3 025
Freshwater Catfishes (*Clarias gariepinus, C. anguillaris*)	6 553
(*Heterobranchus* spp., *Clarias* x *Heterobranchus* hybrids)	2 832
Brackish water catfish (*Chrisichthys nigrodigitatus*)	1 515
Carps (common carp, Indian carps, gold fishes)	1 280
Heterotis niloticus	654
Mullets	336
Snakehead (*Parachanna obscura*)	297
Other fishes	2 921
Total	30 776

Constraints to aquaculture development in Nigeria

Skilled personnel

Aquaculture is a multi-disciplinary endeavour. Therefore, adequately trained personnel with a broad multi-disciplinary orientation who are capable of identifying and addressing deficiencies in aquaculture production project are vital. The shortage of such well-trained staff is a major constraint to aquaculture development in Nigeria. In an effort to combat this shortage, the government has established 20 Universities, including three Universities of Agriculture and four Universities of Technology, which offer undergraduate and post-graduate courses in fisheries/aquaculture. In addition, three Colleges of Fisheries and 10 Colleges of Agriculture have diploma programmes for the technical personnel. Also, three national research institutes are dedicated to fisheries and aquaculture research.

Fingerlings

At present, wild eggs, fry, fingerlings and juveniles comprise the bulk of fish seed available for subsistence aquaculture in Nigeria. Stock quality and quantity are unreliable; they cannot form the basis for commercial/intensive aquaculture. Many rural fish farmers are dependent on government support for fish seed. Even with government subsidy, fish seed prices are generally high, constituting 25 percent of operation costs. Two factors keep fingerling prices high: inefficient government breeding centres and limited supply from private hatcheries. Success has been recorded in the hatchery production of monosex tilapias, common carp, clariid catfishes, including the hybrids of *Clarias* and *Heterobranchus* (Table 2).

Table 2. Fish seed production (millions) in 2000

Fish species	Government Projects	Private Hatcheries	Total
Monosex (hybrid) tilapias	1.5	-	1.5
Clariid catfishes (including hybrids)	4.5	10.0	14.5
Carps (common and Indian major)	-	2.5	2.5
Total	6.0	12.5	18.5

The technology for breeding, selected popular species out of season has been developed, standardized and made available to farmers, however, the high cost and local scarcity of

imported synthetic hormones remains a problem. There are 20 fish seed multiplication projects funded by the government and sited all around the country. These projects are in different stages of disrepair and neglect.

Fish feeds

The absence of a fish feed industry is a second major constraint to aquaculture development in Nigeria. Semi-intensive and intensive aquaculture production systems involve input of supplementary and complete feeds, which account for up to 40 percent and 60 percent of production costs, respectively. The majority of fish feeds produced, 69.75 percent, are farm-made although some commercial feed pellets are produced on demand by a few animal feed millers. The two main feeds produced are one containing 30–35 percent crude protein for herbivorous/omnivorous species and one containing 45–50 percent crude protein for carnivorous species. In 2000, the Nigerian aquaculture industry consumed an estimated 35 570 tonnes of feed (Table 3).

Table 3. Nigerian fish feed production (tonnes) in 2000

Feed type	Farm-made	Commercial	Total
Tilapia (low-protein)	14 258	6 554	20 812
Catfish (high protein)	10 552	4 206	14 758
Total	24 810	10 760	35 570

Credit

Another limiting factor to aquaculture development in Nigeria is credit. There are both formal and informal sources of financing in Nigeria. The relative ease of obtaining credit without administrative delays, non-insistence on collateral and flexibility in repayment programmes make the informal sources very popular among small-scale fish farmers. However, they have limitations, such as small size of loans and high interest rates. Formal sources of credit, banks and cooperatives, lend at regulated interest rates but normally require some collateral. Bank officials consider aquaculture a high-risk venture and this does not encourage loan processing. There is often a widespread distrust of these financial institutions, especially in rural areas, because of bureaucratic procedures, delays and strict terms.

Future outlook of aquaculture in Nigeria

While continuing support to smallholder aquaculture, commercial aquaculture must also be encouraged through the dissemination of existing research results to entrepreneurs via extension agents. This would ensure that project failures are kept to a minimum, new entrants are encouraged into aquaculture and that project design and implementation is based on solid biology and economics. Projects must be market-driven as much as possible, with government subsidies kept to a minimum. Ultimately, aquaculture must pay its way, like any other business.

There is a clear need for integration of aquaculture with other agricultural practices. Aquaculture in conditions of limited water supply must be integrated into a multiple water use paradigm, such as irrigation/aquaculture/livestock and horticultural practices, especially vegetable production. Such integration creates synergy in resource exploitation and kindles interest in aquaculture among new entrants who are already conversant in animal husbandry.

The extensive creeks in the Niger delta could be ranched in the manner that milkfish (*Chanos chanos*) is currently produced in the Philippines. The development of cage culture in reservoirs and farm dams, as well as the tank-based fish culture in peri-urban sites, will enhance fish culture production. Furthermore, integrated rural development models in Nigeria must make aquaculture a central component and not peripheral, as has been the tradition up to now. To a large degree, the government is deeply involved and

is an active player in aquaculture development. It is now generally accepted wisdom in development economic circles that government is not an ideal innovator. The role of government, therefore, must be transformed to that of provider of nutrients for aquaculture by providing good legislation, credit schemes, infrastructure and a general enabling environment.

A viable approach to aquaculture development in Nigeria must include long-term technical extension as well as long-term financial and marketing assistance directed at well-defined and promising target groups. Projects must have commercial viability so that aquaculture can become a success story, a generator of income, employment and food. External assistance will be essential, but it should be planned more carefully and designed with longer time frames to be sustainable.

CURRENT STATUS OF AQUACULTURE IN SIERRA LEONE

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Ministry of Fisheries and Marine Resources

Sierra Leone lies between 7° N and 10° N, and between 10° 30‘ W and 13° W’. It is bordered to the Northwest, North and Northeast by the Republic of Guinea and to the Southeast by Liberia. The population is estimated at about 4 million (1985 census). The fisheries of Sierra Leone are divided into three major sectors:

- The artisanal fishery operating in estuaries and inshore waters extending from the shoreline to a depth of 15–45 m.
- The industrial fishery operating in the open deep sea waters whose fleets include trawlers, shrimpers, canoe support vessels (motherships) and carriers.
- Inland fisheries and aquaculture. The inland fishery is mostly in rivers, a few lakes, floodplains and swamps with a total estimated annual production of 15 000 tonnes. In aquaculture, the species of fish and shellfish that have been cultured include mullets, catfish, tilapia and oysters. None of them has been commercialized.

Riverine floodplains are widespread, particularly in the southern coastal belt and inland lowlands. At present, these ecosystems are used on a subsistence basis. However, the integration of fish and rice culture on a commercial scale offers a good potential for fish production from inland valley swamps, the riverine floodplains and boliland areas.

Rationale for aquaculture development

Fish supply in Sierra Leone is largely from capture fisheries. The current fish production from the marine environment, consisting mostly of industrial and artisanal fisheries, is about 70 000 tonnes of fish annually. Artisanal fisheries are the main source of protein for a large majority of Sierra Leoneans whilst the industrial sector generates employment and revenue. Inland fisheries in Sierra Leone are not well developed and are characterized by primitive technology. Aquaculture, on a commercial basis, has never taken off, but the potential for protein supply from this source and generation of income and employment in rural households could be immense.

The ministry has realized for a long time that fish farming can be a viable alternative to capture fishing, not only for increasing protein availability, but for improving household economies, employment, etc. In this respect, the main priority for the ministry after the war has been the provision of community ponds in various chiefdoms in non-coastal districts.

Over recent years, average per capita fish consumption has declined significantly, attributed to declining catches from the marine fisheries resulting from probable overfishing, loss of fishing equipment by artisanal fishermen due to the war and reduction in the industrial fishing fleet. In order to boost fish production, the ministry has re-oriented its strategy by placing emphasis on fish farming in its policy documents.

Aquaculture practices in Sierra Leone

Experimental fish culture
The ministry had experimental fish farming stations in Bo (12 ponds of 425–900 m^2) and Makali (8 ponds of 300–400 m^2). They were established with the expressed purpose of

propagating commercial fish ponds in the provinces by acting as centres for fingerling production of *Oreochromis niloticus*. These breeding stations provide source of fingerlings for distribution to various parts of the country for propagation. These experimental ponds were abandoned during the war but have now been rehabilitated by the African Development Bank/Government of Sierra Leone Marine Fisheries Project and the Department of International Development (DFID). An experimental oyster culture project was implemented in Sierra Leone between the late 1970s and early 1980s. The project's main aims were to develop an improved technique for culturing West African Mangrove Oysters (*Crassostrea tulipa*), commercial production and marketing of improved cultured product, enhanced growth performance and quality. The biological studies included fouling, seed collection and separation as well as growth. Economic analyses of various culture techniques were undertaken and the study established that the raft culture method was an economic and viable method of commercially producing oysters in Sierra Leone. The extension phase of the project was, however, not successful as commercial oysters farmers did not take up the new technique. The reasons for this unsuccessful phase were attributed to initial investment cost, availability of materials, etc. In the late 1980s, the Sierra Fishing Company undertook feasibility studies for shrimp mariculture. The ministry is desirous of promoting this culture technique. Sierra Fishing Company has now indicated their willingness to try shrimp culture on a commercial basis. Likewise, cage culture has never been practised in Sierra Leone but the private sector is being wooed to invest into this culture technique.

Subsistence fish culture
Tilapia culture is being conducted at subsistence levels in the interior of the country. With funds from the Highly Indebted Poor Countries (HIPC) initiative, the ministry rehabilitated disused ponds and constructed over 60 community ponds in various regions of the country, each with a surface area of 400 m^2. The strategy is to make fresh fish available to non-coastal regions in the country through community training and participation in fishpond management. The experimental stations at Bo and Makali have been utilized as sources of fingerlings for the community ponds. Due to its resilience and sturdiness, tilapia have been successfully cultured in Sierra Leone and continue to be the main species for propagation. The initial seed for culture of this species was obtained from Ivory Coast nearly 20 years ago. Continuous inbreeding has now had a negative effect on the performance and quality of this species resulting in poor growth. The ministry is now looking at the possibility of promoting the culture of other species like catfish, carp and other species of tilapia.

The future for aquaculture in Sierra Leone

Undoubtedly, fish farming can offer real hope to communities far removed from natural water bodies in terms of protein supplement, employment, cash income and stability. But the prospects for commercial fish farming have never come to fruition because of impediments like:

- poor extension;
- inadequately trained middle-level labour force;
- poor logistics, including vehicles, motor-bikes and bicycles, etc.;
- little scientific application.

Recently, great interest has been shown by donor agencies and the private sector in fish farming in the country. There are proposals for consideration by the Arab Development Bank, FAO, private citizens and others. Our President, Alhaji Ahmad Tejan Kabba, has pronounced that no Sierra Leonean should go to bed hungry by the year 2007. We intend to attain the bulk of the fish component of this food security through aquaculture.

SMALL-SCALE AQUACULTURE IN UGANDA

Wilson Mwanja
Ministry of Livestock, Animal Industry and Fisheries

In Uganda, small-scale farmers can be characterized as largely poor, practicing aquaculture mainly as part of a subsistence farming system. Ponds are usually <500 m^2 and constructed by family labour. There are low or no inputs with little or no routine management. Those with some training usually fertilize with chicken droppings, cow dung and other organic wastes.

Stocking of ponds is usually unplanned or at least unquantified and is in most cases at very low densities with seed received from a neighbour, relative or fellow farmer, usually at little or no cost. At the small-scale level, aquaculture serves to diversify the farm by utilizing land (wetland) that the farmer would not ordinarily engage for production. The presence of wetland and some basic information on fish farming are the driving inducements for adopting aquaculture at this level. Consequently, even when production is good, there is no drive for the fish farmer to harvest for market; instead it is harvested whenever the family wants to eat fish. With fertile land, a well-aerated pond and adequate water supply, small-scale fish farmers are able to meet their animal protein requirements and even extend a hand to neighbours, friends or relatives. Occasionally, they also sell some extra fish on the pond bank at locally depressed prices. Ponds are normally stocked once and depend on reproduction within the pond for replenishment. Production is usually in the range of 5–10 kg/100 m^2 pond surface or 500–1000 kg/ha/year. In Uganda, the number of small-scale ponds is estimated at 11 000–15 000 of which nearly 80 percent are currently active.

Constraints to growth

Despite 50 years of aquaculture in the country, the technical expertise available to the sector is very limited. Mid-level training at the Fisheries Training Institute only started in late 1980s. The National University had its first graduates in Fisheries and Aquaculture only in 2003. Prior to last year, university graduates (including the author) were given only theoretical information on fish culture with no practical or technical training. Specialized training was only available outside of the country.

Limited expansion and growth of aquaculture has also been attributed to its failure to integrate into the local economy and/or the existing farming system. As a stand-alone enterprise, aquaculture faces resistance from risk-averse, small-scale farmers. Current efforts are aimed at encouraging would-be fish farmers to use technology that can create synergies with other farm enterprises, thus increasing production and profits, while lowering overall risk within the farming system. A better understanding of markets will also help aquaculture accommodate local fish consumption patterns. Expansion of aquaculture depends on the availability of good extension, credit and farm inputs, especially quality seed. Until 1990, Uganda produced only about 50 000 quality fingerlings a year from a single source – the national Aquaculture Research and Development Center. As a response to the market which was created under a national stocking programme for small dams, over 50 private hatcheries have been established, producing some 10–20 million fingerlings annually. The availability of fingerlings and fish reproduction expertise has opened the door for some limited improvement in aquaculture production. However, inputs at smallholder level and lack of credit to purchase inputs remain strongly limiting factors.

A market-driven transition

With rising market prices for fish, increased government support, the demand for agriculture options and stagnant supply from capture fisheries, farmers are beginning to adopt larger ponds of >1 000 m^2 and higher stocking densities, especially for African catfish, *Clarias gariepinus*. The profit motive has been behind this latest surge in interest in aquaculture, and farmers with access to land and labour are enlarging their ponds both in size and number. Increasingly, seed is procured from specialized private commercial hatcheries.

More and more farmers are planning their production around markets and are searching for technical assistance from private technical service providers. The current estimate is that 20 to 30 percent of subsistence ponds have been transformed into profitable small-scale production units. We are beginning to see more organized marketing of farmed fish where fish are either sold into more lucrative urban markets or processed (salted and sun dried) for off-season or sale in areas where fish are in short supply. The key motivators for these changes are increased fish demand/prices and increased access to quality seed, which had frustrated the farmers in the past. Also associated with this improvement in production is the entry into aquaculture of the "middle-class'" Encouraged by the potential for profit, a number of middle-class people and traders with land and water have taken on fish farming as an added activity on their farms.

In addition, a few of these middle-class farmers have made the transition to "commercial" aquaculture. We are now seeing the emergence of farmers who are willing to pay for private technical expertise, use more intense planning and grow fish for targeted markets. These farmers are driven purely by profit and are in turn driving the growth of aquaculture infrastructure such as hatcheries that can produce quality seed in the quantities demanded and in the proper season for stocking. There are about 2 000 of these new farms with total pond surfaces in the range of 1 500 to 40 000 m^2, representing 20 to 30 percent of active pond surface. Most began as hatcheries targeting the dam stocking programme as a market, but are now diversifying into grow-out of foodfish. Production technology on these commercial farms remains, however, extensive.

Industrial and/or more intensified fish culture is only beginning to take root in Uganda. Most industrial farms are either in the stage of putting infrastructure in place or just beginning production. Industrial aquaculture is capital intensive and based on experienced technical expertise, often in the form of foreign technicians. Commercial fish feed production is only just starting, with trials currently being conducted by one company. The targeted market for industrial aquaculture is primarily the underutilized fish processing capacity resulting from declines in the Lake Victoria fishery. Most of companies or firms in this category plan to use small commercial fish farms in out-grower schemes where they provide the basic inputs including seed and feed in return for purchase at a negotiated price of fish produced.

Government action

In an effort to improve production, the Department of Fisheries Resources has recently put in place a number of initiatives, the impact of which is being monitored. These include the following:

- The typical government extension officer is far removed from realities on the ground and generally lacks the practical knowledge of fish culture that would permit him to make feasible suggestions to farmers. Ultimately, the government hopes that the need for technology can be supplied by community-level technicians trained in "hands-on" practical aquaculture. In the meantime, bilateral arrangements have been made with Egypt and China to provide such expertise and assist in training.

- Advocating an economically realistic minimum pond facility of at least two ponds of minimum 1 000 m^2. Farmers following these recommendations will qualify for improved seed procured through government subsidies.
- Issuing appropriate pond management guidelines, including pond construction, pond preparation and conditioning, fertilization, flood control and drainability.
- Advocating production and use of quality seed. Realizing that lack of quality seed was a big impediment to small-scale aquaculture, we moved to discourage farmer-to-farmer supply and made regulations that allow only for seed distribution by approved hatchery operators with demonstrable ability to deliver quality seed.
- A major limiting factor to further expansion of aquaculture production at all levels has been the lack of fish feeds and/or lack of knowledge on their formulation, especially at the small-scale level. We are planning an approach similar to that used with quality seed to promote the use of appropriate fish feeds.
- Cognizant of the limitation of small-scale farmers to procure quality seed, properly manage fishponds, market the fish and restock without assistance, the government is encouraging the development of commercial outgrower (satellite) schemes. Large seed producers with limited grow-out capacity are being asked to enter into agreements with small-scale farmers whereby the large farms provide basic inputs in exchange for marketable fish at preferential prices.
- To ensure that farmers have access to appropriate technology, government has continued to fund the National Aquaculture Research and Development Centre. Participatory on-farm research and trials are expected to produce technology options appropriate to the small-scale farmer's situation.
- Other government interventions include:
    - aligning small-scale aquaculture with the newly privatized extension service, the National Agriculture Advisory System (NAADS);
    - searching for appropriate credit mechanisms;
    - encouraging market-oriented aquaculture at all levels;
    - creating farmer groups that can help farmers access services and markets;
    - helping farmers to process and market farmed fish.

Through the above interventions, the Government of Uganda has been able to move aquaculture production from less than 300 tonnes to nearly 5 000 tonnes per year in only 4 years time. With the private sector driving the process, we expect aquaculture at all levels to progress rapidly toward the set goal of 20 000 tonnes by 2006, 40 percent of which is expected out of improved small-scale aquaculture production units.

EXPERIENCES WITH SMALL-SCALE AQUACULTURE IN ZIMBABWE

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Aquaculture was introduced into Zimbabwe in the 1950s with a programme initiated by the colonial administration to develop trout farming, the stocking of dams and sport fishing, which by the 1980s had grown into some 52 commercial farms using modern technology.

Some limited culture of tilapia was also started and in the early 1990s this subsector was producing about 80 tonnes per annum of tilapia, carp and catfish from an estimated 40 ha of small-scale ponds.

Since the 1980s the situation has changed considerably. The commercial aquaculture sector has consolidated, and by the mid-1990s half of the farms were out of business. The number of small-scale farmers was also considerably reduced. At least, a part of these declines can be attributed to political turmoil, in particularly the reorganization of the two ministries (Agriculture, in charge of extension, training and seed production; Wildlife, primarily in charge of research and regulation) involved in promoting and supporting aquaculture development.

In addition, the socio-economic status of the country has declined over the last four years as a consequence of the government's land redistribution programme. Declines in disposable income among consumers have been accompanied by loss of capacity in the feed sector, reduced budgets for research and extension and wholesale alteration of the agricultural sector in general. Nascent fish farmer associations, both large- and small-scale, have become moribund during the period of economic hardship.

Despite all this, the extension services continue to try to support the growth of the aquaculture sector. Regular weeklong courses are held for field-based agents. In addition, farmer training is provided for in both ad hoc and more formal settings as budgets allow. Researchers working in the area of fish reproduction and breeding are making fingerlings available to farmers. These are distributed free of charge by the extension services.

The Zimbabwe climate is good for aquaculture and potential is considered to be high, both in terms of market and the biotechnical factors involved in production. The main constraints/challenges to aquaculture development in Zimbabwe can be summarized as:

Macro-economic environment:

- limited opportunities to access funds as international financing is currently frozen;
- high cost of key inputs, especially feeds;
- low disposable incomes within the local market.

Institutional capacity:

- fragmented & "misplaced" responsibilities;
- declining quantity and quality of. trained and experienced staff;
- inadequate funding;
- seemingly permanent state of flux in key institutions.

Lack of effective aquaculture development strategies:

- Potential of aquaculture to provide opportunities for economic growth not appreciated.
- Aquaculture viewed as a sideline, hobby type activity.