Synthesis report: Assessment of national aquaculture programmes and policies in Sub-Saharan Africa

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Disclaimers:
1. The views and opinions stated in this review are those of the authors and SARNISSA project partners not necessarily those of the EC.
2. This synthesis report builds mainly on the analysis of 10 in-country reviews commissioned by SARNISSA, the review of selected literature as well as discussions held on the SARNISSA e-forum. It does not pretend to synthesize or provide a complete overview of all existing publications in the field of aquaculture.
## SARNISSA: Sustainable Aquaculture Research Networks in Sub-Saharan Africa

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1. Introduction

The EC funded SARNISSA project is building a sustainable aquaculture research network with a focus on sub-Saharan Africa (SSA). The research network is contributing to knowledge-based aquaculture development, building on an existing knowledge platform, the ‘Aquaculture Compendium’. To achieve its objectives, the project is working with the entire range of relevant stakeholder groups, including academic research institutions, the small and medium enterprise (SME) sector, government, non-governmental organizations (NGOs), and community-based organizations and farmers associations, with links to small-scale fish farmers.

The project has been developed and launched within the framework of the generally-held expectation that, with the increasing impact of over-fishing and climate change on the fishing industry, as well as on aquatic biodiversity worldwide, the demand for improved aquaculture technologies will greatly increase in the next decade or so. These global developments will present additional challenges for aquaculture in SSA. The time is right for sub-Saharan African aquaculture to receive an impetus for accelerated development, incorporating state of the art science and technology from around the world. Recent trends suggest an upturn, with countries such as Nigeria, Uganda, Ghana, Mozambique and South Africa, amongst others, showing encouraging development and increases in aquaculture production, a development that offers considerable promise in sharing these successes with neighbouring countries, a mechanism SARNISSA is building on.

### Defining aquaculture

The project adopts the FAO definition of aquaculture as to distinguish it from marine or freshwater fisheries-based activities:

“Aquaculture is the farming of aquatic organisms: fish, molluscs, crustaceans, aquatic plants, crocodiles, alligators, turtles, and amphibians. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of capture fisheries”


Aquaculture in Africa can take place in rural, peri-urban and urban environments. A wide variety of farmed species and production systems for aquaculture are found across the continent, including tilapia and catfish, produced in monoculture or integrated systems, in ponds, tanks and cages. Production and marketing can take place at commercial or subsistence levels. Both small-scale and intensive commercial systems are subject to mutually beneficial information and contacts sharing, as well as to potential research and development collaborations between/among them.

This document is a synthesis of analytical reviews of the national aquaculture policies of ten different countries in SSA that were conducted as part of the SARNISSA project, as well as significant discussion threads from the SARNISSA English and French language e-forums. Though the report also includes a revision of some additional literature, it does not synthesise or provide a complete overview of other existing and relevant publications in the field of aquaculture policy in SSA.

The individual country reviews describe the past and current status of the country’s aquaculture and then go on to analyse the successes and failures of projects, programmes and government policies in shaping or developing aquaculture within each country. They also put forward recommendations on needs and priorities for a future aquaculture development agenda. This synthesis report will highlight success factors and constraints to sustainable and profitable aquaculture projects and initiatives, and outline the roles that national governments, research institutes, universities, and other stakeholders can and do play in the development of sustainable aquaculture in SSA. In doing so, valuable examples and recommendations will be provided for other countries, regions and institutions.

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1 The in-country policy reviews were implemented in Malawi, South-Africa, Zambia, Madagascar, Uganda, Kenya, Cameroon, RD Congo, Ghana and Ivory Coast. All the original reviews can be viewed and downloaded from the ([http://www.sarnissa.org/tiki-index.php?page=SARNISSA++Project++Publications](http://www.sarnissa.org/tiki-index.php?page=SARNISSA++Project++Publications)) website.
2. Executive Summary - Key findings

Potential for aquaculture development
In general terms, aquaculture has the potential to contribute to food security, poverty alleviation or economic development. However, to enhance this potential it will be necessary to better define the precise policy goals it should respond to (household food security or national food supply?, income generation for small entrepreneurs or earning export exchanges?), the specific aquaculture production systems to be supported and the appropriate intervention and policy measures.

In most countries rural fish ponds with extensive/semi-intensive management are the most commonly used aquaculture systems. Madagascar, Malawi, South Africa and Zambia, amongst others, have rural, subsistence-oriented fish ponds and a more intensive commercial sector, comprising small-, medium-, and large-scale aquaculture enterprises. Each of these aquaculture production systems contribute in varying degrees to different policy goals. Where household food security and increased resilience for the poor is the main objective, (partially) subsidised and longer-term support to subsistence and integrated fish farming systems, development of locally appropriate production systems and training, if affordable, may be a worthwhile investment. Where income generation and job creation is the main target, promotion of small- and medium-scale aquaculture enterprises may be a viable strategy, though this will probably not reach the poorest and most vulnerable groups directly. Where foreign exchange earnings are sought, large(r)-scale commercial aquaculture could be promoted, though preferably cash returns to local economies should be re-invested in new and effective development schemes. Interventions and impact pathways leading from aquaculture production to policy goals such as local food production, local income generation or export earnings are different, and this has important implications for national policies aimed at encouraging the growth of aquaculture.

Constraints and success factors for aquaculture development
There is large potential for the growth of aquaculture in SSA. Of the total quantity of aquatic products marketed in Africa, only a small part (~ 200,000 tonnes) is produced by aquaculture. Although significant funds have been invested in aquaculture in sub-Saharan African countries over the past four decades, the actual results in terms of aquaculture expansion, increases in production and income generation have been disappointing. Depending on the specific aquaculture system to be promoted, low pond productivity, shortages of availability of good feed and seeds, good quality information or appropriate technologies and limited access to capital and markets have constrained the development of the sector. Furthermore, and outside of the limited commercial sector-driven producers, the other largely donor-driven projects have often not been based on values and needs/priorities in the receiving communities, nor have they had the sustained uptake of aquaculture as a key principle in mind. As a result, many fish farming initiatives have been abandoned once projects and their associated supporting finances have ended.

Success factors that lead to more sustainable aquaculture development include: development and adoption of locally appropriate and viable production systems and technologies; longer-term training and technical assistance; the presence of a commercial hatchery sector and agriculture industry with by-products and the presence of local feed industries; availability of credit and other means of investment in infrastructure and specialized aquaculture equipment; the development of niche markets and connection to urban and international markets; and the presence of strong farmer organizations and/or of conglomerates/networks of stakeholders, including farmers’ organizations, private enterprises, government and research institutes.

Important roles for research, training and extension
Research institutes and universities should work together with individual farmers and farmers’ organizations and other stakeholders, in a concerted and coordinated way to develop locally adapted and viable answers to the variety of challenges mentioned here. The development of applied technologies, improved breeding and feeding practices, marketing solutions and the evaluation of programmes and policies in terms of the benefits for the individual farmer/entrepreneur are key factors for a successful sector. Direct involvement of farmers and other stakeholders in the process of priority setting, choice of technology and actual research makes adoption of results more likely. Increased funding for education and research will only become available if research responds to farmers needs, builds on previous research and shows more demonstrable impacts in the short term.

Knowledge exchange between researchers and policy makers is also important, enhancing better informed policy making. Baseline studies should form the basis for all policy development, whereby the concerns of policy makers are part of the equation. Effective monitoring of project and government performance and documentation of good practices are also roles that can be played by research institutes.
Enhancing policy implementation
Facilitating national strategies and policy and legislative frameworks are important prerequisites for sustainable aquaculture development. In order to formulate an effective policy, it is important to have a clear strategic vision on aquaculture, both as a separate sector (and not just as a component of the fisheries or agriculture sector) and as a part of an overall national development strategy, which clearly defines what are the most effective roles and activities for government as compared to the private, commercial and NGO sectors. Thorough baseline studies are needed, drawing and learning from previous experiences to form the bases for such a policy framework and strategic vision in each country. Such studies will also help gearing international donor proposals and funding to specific country needs. Where such strategic vision is lacking, the type and scale of aquaculture a country seeks to promote and how progress for change will be monitored is often unclear.

Other important factors for the success of aquaculture policies and strategies seem to be dependent on the representation of stakeholders in the policy formulation process; in policy dissemination, the presence of sufficiently qualified, experienced and enthusiastic staff, inter-ministerial and inter-actor coordination in implementation, availability of resources and, most importantly, realistic and clearly set budgets for implementation.
3. Potential of aquaculture development in sub-Saharan Africa?

This chapter describes the (potential) contribution of aquaculture development in SSA to various policy goals, outlines the three (broad) types of aquaculture found in the region and analyses some commonly found approaches taken to promote development of the sector. Constraints and success factors related to production, processing and marketing of aquaculture will be further discussed in Chapter 4. Issues related to the need for more participatory research, extension and training are discussed in Chapter 5, while Chapter 6 will deal with the policy and legislative framework needed to enhance aquaculture development.

**Contribution to different policy goals**

The (potential) contribution that aquaculture can make to different policy goals is well documented in many studies and publications. Aquaculture has potential to contribute to food security and nutrition, poverty alleviation, local economic (or rural) development and foreign exchange earnings, though, generally, reliable statistics are quite hard to find, depending, for example, on the used definition of an aquaculture producer (for example, individuals with fish ponds as opposed to those actually harvesting from them) and are often inflated because government officials believe that it will encourage potential investors and funders.

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**MINISTRY OF FISHERIES DEVELOPMENT**

**Launch of the Oceans’ and Fisheries Policy Venue: Mombasa, on 9th April, 2009**

Industry earns Kenya Sh.8b in foreign exchange

*Source: Saturday nation, Kenya, April 4, 2009 (Ksh 8 b equals 95 million USD)*

Fish provides an important source of nutrition for 2.6 billion people worldwide. Provisional FAO statistics for 2008 show that aquaculture now supplies almost half of all fish consumed globally. Farm gate value is estimated at US$ 81 billion, but said to be 2-3 times this figure if looked at from a value chain perspective (Beveridge et al., 2010). Employment in commercial aquaculture was estimated by the FAO to reach 11.3 million by 2004 (FAO, 2006, cited in Brummett and Rana, 2010).

Apart from the use of, often overrated and not-locally specific, statistics, a second problem lies in the definitions used. Both food security and poverty alleviation are used ambiguously and it is often not clearly spelled out in policy and programme objectives which facets of poverty or food security or which type of beneficiaries are targeted.

Food security may be looked upon from the point of view of household food security and (diversification of) nutrition. Many poor farmers consume most or large parts of the fish they grow. Fish may be an important protein source and part of their diet. Food security may also be looked upon from the point of view of national food security. Here, the main aim is to associate increased production with increased availability of (fresh) fish and other aquaculture products on the market at affordable prices.

Poverty alleviation may have as principal goal in mind, such as increased household food security or increased food availability for lower-income consumers. It may, however, also be directly aimed at the generation of farm income and job creation; currently the main reasons cited for promoting investment in aquaculture. Whether for food or income, beneficiaries, interventions and impact pathways leading from aquaculture production to poverty alleviation are, however, different, and this has important implications for national policies aimed at encouraging the growth of aquaculture. Some
interventions and investments to increase aquaculture production will have direct implications for lower-income farmers; others may have trickle-down affects on poverty, while again others may not have any positive outcomes for the poor. After all, a commercial aquaculture enterprise, like any other enterprise wants to maximize return on investment and is seldom concerned about providing cheap food for the poor. Often fish that is sold for cash is traded at wealthier urban markets (Brummett and Rana, 2010).

Policy and programme development for aquaculture would benefit from clearer, more realistic and explicit, specific policy goals and objectives, and related choices for the types of aquaculture systems to be promoted, the beneficiaries to be targeted and the interventions and support measures to be put in place. This may mean that food security, income and employment or foreign exchange earning must be traded against each other in the setting of priorities, or that other development strategies, not including aquaculture, are more appropriate options to achieve given policy goals. This priority setting should be carried out with clear knowledge of the budget that is available. Previously, and still to a certain extent in SSA, this process of matching policy goals, activities and funding into national aquaculture plans has not taken place. Often this was (and still is) because SSA governments received considerable funds from international donors based on very general and non-specific project proposals. With the economic climate and former donor driven community beginning to change for aquaculture development in SSA, cost-benefit analysis and making tradeoffs will become even more important. As can be seen from all of the SARNISSA in-country reviews, this process of including clear cost estimations and budgets within National Planning and Strategy documents was never prioritized (see also Chapter 6).

**Current low performance of the aquaculture sector in sub-Saharan Africa**

Driven by poverty alleviation and rural development, stagnant or collapsing capture fisheries and increasing demand for fish, aquaculture development in sub-Saharan Africa has been receiving a lot of attention and, as mentioned above, funding over the past years. As results generally have been disappointing, it would be easy to draw the conclusion that aquaculture does not work in Africa. It is estimated for example that, despite the large investments made, fish from both aquaculture and capture fisheries still only contribute about 4% to Malawi’s GDP. The aquaculture sector in Malawi only provides about 2% of the nation’s fish production (Banda et al., 2009), though other countries including Egypt, Nigeria and Uganda show more important (and rapid) increases in aquaculture production.

According to Lazard et al. (1991), African aquaculture development received US$ 72.5 million from 1978 to 1984, which is nearly one third of the funds received by Asia and the Pacific. Ninety percent of global aquaculture produce, however, still comes from Asia. This is also related to the abundance of adequate water resources in Asia, higher population densities (making up larger urban markets with, generally, better transport and road networks) and the traditions of fish catching from rice fields and swamps, making the transition from catching to culturing fish more easy (Beveridge at el., 2010).

Notwithstanding slow regional growth in aquaculture, natural conditions for growing fish are favourable in many African countries, while available land, water and labour are still relatively inexpensive. Countries like Ghana, Kenya and South Africa have the benefit of greater occurrence of suitable fish species. Other countries and areas such as Northern Cameroon have insufficient rainfall for pond aquaculture (though cage-culture can be developed in man-made reservoirs), while aquaculture intensification is also limited because of low levels of technological development. In areas such as in West Central Africa, Ghana, Nigeria, and Ivory Coast, two harvests per year are attainable for tilapia, *Clarias* and prawns, whilst in countries further south, such as Zambia, Namibia, Malawi, South Africa, due to low winter temperatures, often there is only one harvest, having obvious consequences for economic viability. For species such as trout, climatic constraints and altitude do not permit their use outside certain zones such as the highlands of Kenya, Tanzania, Ethiopia, Lesotho and South Africa. Constraints, such as with koi carp farming, may also relate to disease and skills associated with breeding and grading of varieties. In yet other countries, such as Malawi, exotic species such as carp and Nile tilapia cannot be farmed because of fears of ecological impacts. In these cases, research is already pointing towards alternative and possibly more profitable fish species. This trade-off between biodiversity concerns and financial viability of aquaculture production systems is already giving certain countries competitive advantages in regional markets as they have welcomed the introduction of non-indigenous, but faster-growing species compared to some of their neighbours.

In most countries rural fish ponds with extensive management are the most commonly used aquaculture system. Madagascar, Malawi, South Africa and Zambia also have a more intensive commercial sector, with commercial cage culture now beginning to produce significant volumes of tilapia in Zimbabwe, Ghana and Uganda, and shrimp in Madagascar. The ten SARNISSA in-country reviews describe the presence of the following three main production systems (see also Table 3.1):

1. An extensive, smallholder system in rural or peri-urban areas with mostly ponds between 100 and 200 m² in area. Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) are the most widely farmed fish species, produced using available on-farm resources (farm wastes and by-products) and normally employing family labour. Household food security and income generation is the key issue for this type of aquaculture systems. Fish ponds are
also being used for water storage and irrigation and therefore reduce risk of crop failure and increases resilience in times of drought. Yields vary widely from pond to pond and from country to country, but are commonly found to be in the range of 1-2.5 tonnes per ha per year. Production of Nile tilapia is often hampered by poor pond construction, water management and fertilization, lack of manure and technical constraints, such as difficulties of mono-sex fry production, poor quality fingerlings, overstocking and poor feeding practices. The latter in part due to a lack of good quality and reasonably priced feed. Generally these issues cannot easily be resolved by smallholder farmers individually.

2. A semi-intensive production system, where farmers have been supported more intensively with training and technical assistance. Ponds are somewhat larger (around 400 m²) and more expensive inputs such as better quality feeds, fertilizers and seed (sometimes mono-sex tilapia fingerlings are used). Under better management these relatively higher input systems have higher production; production levels of around 3-8 tonnes per ha per year (Pouomogne and Diemuth, 2008). These small-scale fish farms/businesses employ a more market-oriented production system to produce fish for local and urban markets. In areas with good market access, profits from even small-scale investments can be significant, as annual net profits from highly productive, small-scale fish farms (0.1-0.3 ha) may range from US$ 600 to US$ 1300 (Brummett and Rana, 2010). Income generation and cash earnings are the main objective for this sector.

3. Medium and/or large size commercial fish farming with very high inputs and high production levels, often found around large cities. Production systems consist either of tilapia production in lake based cage farming systems (Ghana and Zimbabwe) or large fish ponds (Zambia) or for niche markets such as trout and crocodile farming (Kenya). Commercial shrimp production (Madagascar, producing *Penaeus monodon*), and production of abalone,
mussels and oysters (South Africa) (*Haliotis midae*, *Mytilus galloprovincialis* and *Crassostrea gigas*, respectively) in the marine environment provide evidence that commercial farming has potential in Africa. South Africa produces somewhat different species such as rainbow trout (*Oncorhynchus mykiss*) and koi carp (*Cyprinus carpio*). Ornamental fish produced in freshwater environments are for a niche market. In the countries mentioned here, commercial fish farming has begun to develop in the past five years and is beginning to contribute significantly towards the GNP. Produce is principally oriented towards the export market.

Ornamental fish produced in freshwater environments are for a niche market. In the countries mentioned here, commercial fish farming has begun to develop in the past five years and is beginning to contribute significantly towards the GNP. Produce is principally oriented towards the export market.

One example of successful small and large-scale commercial aquaculture development comes from Madagascar. Madagascar has a long history of fish farming. Long-term commitment from donors and large investments in infrastructure have resulted in substantial increases in fish production and sustained involvement of the private sector. The fish farming sector in Madagascar is also characterized by its innovations after successful introduction of shrimp, crab and eel production. From 1976 to 1994, various projects undertook extension activities whereby production of fingerlings by the private sector and extension activities were explicitly combined. Focus was on the introduction of better performing species. Especially in the High Plains of Madagascar, appropriate technologies have been developed and are applied by small-scale producers. Of particular importance was the role played by the private sector in this development, as illustrated below.

### Role of private sector in the development of shrimp farming in Madagascar

Since the nineties Madagascar started small-scale and industrial shrimp farming with the species *Penaeus monodon*, using a semi-intensive production system. The total production, 8,500 metric tonnes, is aimed at export, and is worth Euros 57 million. Other production systems include those for production of algae (for the production of carrageenan) and micro algae, for example, *Spirulina* (see Green Gold of Madagascar video [http://www.terre.tv/fr/1_biodiversit/6_flore/1974_lor-vert-de-madagascar](http://www.terre.tv/fr/1_biodiversit/6_flore/1974_lor-vert-de-madagascar)), which are used for feeding malnourished children. Madagascar also has a long tradition of rice-fish culture systems, which produce fish almost exclusively for the local market, and hence benefit the local economy and improve the nutritional situation of the rural and urban population by providing a substantial source of protein.

Incorporating the private sector in the production of high demanded fingerlings, contributed to a major extent to turning around the past decline in production towards a four-fold increase in five years (Ranaivoson, 2009, p16).
An important potential for aquaculture development in sub-Saharan Africa is related to market demand. Until recently, capture fisheries managed to keep pace with the growth in demand for fish. During the past ten years, however, population growth and decline of capture fisheries has led to demand now significantly outweighing supply and most countries importing fish for consumption. In Ivory Coast, for example, total annual consumption reaches 300,000 tonnes per year, against a national annual production of 100,000 tonnes. Over 70% of consumed fish is thus imported (http://www.continentalnews.fr/actualite/economie,4/cote-d-ivoire-creation-d-une-association-pour-la-filiere-aquacole,9855.html). This results, in principle, in high market potential for aquaculture, and the price consumers are willing to pay for their preferred fish is also relatively high. In response to this situation, many countries have produced strategic development plans for promoting the aquaculture sector.

Many government planning documents thus encourage the growth of aquaculture, often mentioning the need for a more “conducive” policy environment. While fish-growing may be adaptable to a wide range of production systems, doing so in a way that it really benefits the poor is less obvious (Brummet and Rana, 2010).

**High degree of abandonment**

Notwithstanding the undeniable potential for aquaculture in SSA, the present analysis found that production systems that rely entirely on project support and/or support of government institutions are likely to collapse as soon as such support is withdrawn. In Malawi, during 2004, the FAO in collaboration with IFAD promoted integrated irrigated aquaculture; however, 50% of the beneficiaries abandoned the ponds due to discontinued funding from donors. Examples of these dependencies on external support include, for example, subsidized provision of inputs such as broodstock and seed, capital and technical advice. This appears to be the predominant factor in the abandonment of fish ponds and other related aquaculture systems in all ten country analyses. This is also due to the fact that these extensively managed systems are viewed as a secondary or complementary farming activity to household food production and income. Without sufficient resources (or skills) to invest in their maintenance, farmers tend to return to other crop and livestock systems for their livelihoods.

Another reason for abandonment of small-scale aquaculture systems is related to their low profitability. In 1990, Haight et al. observed that of 10,000 aquaculture ponds in Kenya, only 5,000 were actively managed. Ponds were abandoned due to low productivity and, thus, profitability. Smallholder ponds in Malawi yielded on average of 1.4 tonnes/ha/year, representing an annual income of approximately US$ 25/farmer/year, often considered as too low a benefit for farmers to sustain their investments compared with other cash crops such as tobacco (Haigh et al., as mentioned in Ngugi and Manyala (2009), p.6; and Mwale (2009), p.12). Where given in the other SARNISSA documents, figures regarding abandonment fall within a range between 25 and 50%.

### Table 3.1 Principal production systems and their productivity

<table>
<thead>
<tr>
<th>Country (data year)</th>
<th>Principal production system</th>
<th>Average unit size m² total surface</th>
<th>Productivity tonnes/ha.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameroon (2006)</td>
<td>Rural ponds; tilapia, catfish, common carp</td>
<td>200-400</td>
<td>0.2-3.5</td>
</tr>
<tr>
<td>Ivory Coast (2005)</td>
<td>Rural ponds, Urban ponds; tilapia semi-intensive systems; tilapia, carp, catfish</td>
<td>400-600</td>
<td>0.5-8</td>
</tr>
<tr>
<td>Congo DRC (2002)</td>
<td>Rural ponds; tilapia, catfish</td>
<td>400</td>
<td>1-2.7</td>
</tr>
<tr>
<td>Ghana (2006)</td>
<td>Rural ponds; tilapia, catfish</td>
<td>1000</td>
<td>3</td>
</tr>
<tr>
<td>Malawi (2002)</td>
<td>Integrated Fish farming; Chambo, Makumba, Redbreast tilapia, catfish Cage culture</td>
<td>200</td>
<td>0.5-3</td>
</tr>
<tr>
<td>South-Africa (2008)</td>
<td>Abalone, mussels, oysters, finfish Freshwater trout, catfish, ornamental and koi</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Uganda (2005)</td>
<td>Rural ponds; tilapia, catfish Cage culture</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>Zambia (2008)</td>
<td>Commercial ponds; carp crayfish, catfish</td>
<td>10,000</td>
<td>7</td>
</tr>
</tbody>
</table>
In order to address this problem, some of the programmes have stimulated the transition of subsistence farming to small-scale commercial fish farming, but many farmers have changed back to low input-low output fish production for reasons mentioned above. Although high input and high output does not necessarily mean high profit, it is key that profitability is sustained over a longer period of time, compared to other (farming) investments and not completely depend on acquisition of inputs (such as feed) from external sources. However, for food security and increased resilience to be reached by the most poor and vulnerable, partially subsidized support to aquaculture, if affordable, may be viewed as a long-term, worthwhile investment. Where subsidies are not available and/or economic growth is the main objective for the sector, working with commercial farmers makes more sense (Brummett and Rana, 2010, Beveridge et al, 2010).

Profitability of more market-oriented production systems can be increased by improving individual farmers’ business and farm management skills, their access to information, as well as their technical knowledge and performance, in addition to value chain development, improved market access and/or increased scale of production. However, constraints faced by (small-scale) farmers in doing so include, among others, unavailability of start-up capital and operational resources such as quality fingerlings and fish feed (see further Chapter 4). Small-scale farmers may also lack the necessary skills and knowledge to adopt fairly sophisticated technology or the (project) choice of technologies is poorly adapted to local knowledge and circumstances (see also Chapter 5). Recirculation systems, for example, which can be used for hatcheries, allow for high densities of fry and fingerlings, but require high levels of capital and technical know-how to be successful. Sustained, long-term training and technical assistance are thus critical. In Uganda and Ivory Coast, for example, with sustained technical support, some farmers have learned how to hand-sex tilapia, thereby substantially increasing productivity levels and profitability.

Keeping records of inputs and outputs and participatory research could help better determine and document the mechanisms behind how and when a small-scale, medium or large-scale enterprise, producing a specific species, becomes profitable in a given local context and then go on to disseminate these findings to help inform policy makers which further intervention and policy support measures are needed to sustain it. Research in Malawi for example showed that *O. karongae* could very well be a feasible alternative for *O. niloticus*; whereby no mono-sex breeding is needed because *O. karongae* becomes sexually mature when comparatively old/large, thus facilitating the production of a bigger fish without precocious breeding when under stress. However, not enough is known about the fundamental biology of this species (adapted from Mwale, 2009, p.40).

**Lack of applied research and inadequate extension in Malawi**

"Our fish do not grow" is the most common complaint by Malawian fish farmers. This is not unique to Malawian cichlids; it simply illustrates the phenotypic plasticity of tilapias in general. The success of tilapia farming world-wide is a consequence of certain management and genetic interventions. Most important amongst these are controlling reproduction in ponds, providing appropriate and adequate quantities of feed and appropriate fertilisation, selection of appropriate species, hybridisation and development of faster growing strains and mono-sex (all male) farming. If the objective is to produce large fish at the end of the grow-out cycle then either one, or a combination of the above, must be applied in conjunction with appropriate and adequate nutrition and fertilisation. (...) All male tilapia production in Malawi is rare. So far, research institutions have carried out a number of research projects related to the subject but the practice has only recently been approved by the country’s Agricultural Technology Clearing Committee, facilitating the production of all male tilapia for sale to both public and private sector by the National Aquaculture Centre (NAC) and others.

Most Malawian fish farmers are subsistence farmers, who for various reasons cannot afford the risk of improved feeding, fertilisation and management of their fish ponds and are forced to adopt a “low input – low return” farming strategy. To change this approach, particularly in view of the high fish price, it is necessary to demonstrate the (on-farm) profitability of advanced higher yield technologies. However, these technologies are in most instances not available to the farmers.

*It is otherwise inevitable that many farmers will continue with current fish farming practices. The primary reasons why the current practices will persist include, amongst others, the widespread and high degree of poverty, a high percentage of illiteracy, an under-resourced and therefore inefficient extension service and inadequate extension material* (Mwale, 2009, pp 34-35).

Unfortunately, this is also true for many of the sub-Saharan countries covered in the SARNISSA project.
Role of commercial farming
Where the aquaculture sector has developed a more commercial approach and attracted the interest of the private, entrepreneurial sector, as illustrated by the case of Madagascar, and also Nigeria, commercial fish farming has been more successful in some countries, often because commercial enterprises are willing and can afford to invest in improved facilities and production systems and production techniques or choose to produce their own feeds and fingerlings to secure the availability of essential inputs. More profitable species such as rainbow trout, shrimp, abalone, mussels and oysters, and ornamental fish are produced on these farms. High costs of transport, difficult road access and problems with feed and seed availability are, however, cited among the reasons why production goals are not always reached.

Commercial production and processing, Lake Harvest, Zimbabwe

Commercial farms may have a positive impact on the farms around them. They often produce more fingerlings than are needed for their own farms, and may sell these to small-scale farmers, for whom good quality fingerlings are generally very hard to come by. Larger-scale commercial farms also often develop pioneering activities and research, which is disseminated to other farmers. Furthermore, they offer training opportunities for their staff, who may be subsequently employed by extension or technical assistance projects.

Commercial farms in South Africa seem to be among the leaders in technological development and efforts to develop new markets and fish farming activities. Bio-technical issues such as spawning, fingerling production, nutrition, disease control and harvesting have been the subject of extensive research and experimentation.

Commercial fish farming in South Africa
Over the last 7 to 8 years there has been a concerted research effort to develop marine finfish farming, focusing on dusky kob (Argyrosomus japonicus) and yellowtail (Seriola lalandii). The farming of marine finfish is driven largely by increasing demand for fish that cannot be met from fisheries. Several large, land based farms and sea based cage farms are currently in the planning or are in the pilot phase. Open ocean submerged cage culture may well hold the key to scale production of marine fish species in South Africa. However, this is dependent on government zoning suitable waters for aquaculture.

The South African abalone (Haliotis midae) industry is currently going through a period of growth with the successful establishment of commercial abalone production. A number of the abalone farmers have established a dedicated marketing company to promote South African product and market into the extremely lucrative Far Eastern market (Shipton et al, 2009, p.iv).

Many consider that business investors are the key to Nigeria’s undoubted success story in the development of this industry. There is a large aquaculture industry in the country that is primarily market driven by the private sector. Being the most populous country in SSA, the industry has a huge market demand driving it. Since around 2000, institutional support for the rise of peri-urban fish farming in Nigeria has been modest but the high demand and the consumer preference for the Clarias catfish prompted the private sector to employ international consultants who became partners in the industry’s development. The reasons contributing to the industry’s success are identified as: (1) it is market driven with investments by businesses/entrepreneurs at all levels, (2) Investment in sound, well-qualified commercially experienced managers, (3)
Use of a suitable fish species (Clarias catfish being a hardy fish that can be stocked at extremely high densities and still achieve good growth and low feed conversions), (4) Investment in high-production fish hatcheries with use of quality broodstock and some extension support from hatchery operators and (5) Whilst still importing quality commercial fish feeds from Europe, in recent years there has been increased investment in quality fish feed mills with quality control and a wide availability of feed, with some extension support from experienced feed companies (personal communication J. Miller, 24-02-2010).

Whilst support to large-scale commercial farming, for example, by encouraging foreign investment, waiving import duties on essential inputs or applying preferential foreign exchange rates may be easy for national governments, even where political instability and poor infrastructure would otherwise deter investment, benefits to the host country may be minimal. Though sometimes considerable numbers of people are employed on such farms, relatively large amounts of their by-products may be put on the local market and especially enterprises that depend on local suppliers for inputs may inject significant amounts of money into the local economy, foreign exchange earnings often end up being the main positive benefit. Such cash returns to local economies could be important if wisely invested through effective income redistribution schemes, but in many cases they are misspent by ill-advised or ill-intended politicians (Brummet and Rana, 2010).

Lacking the means and leverage of large (foreign) firms, smaller- and medium-scale investors have much more trouble finding sufficient capital to obtain all necessary infrastructure, equipment and inputs and finding qualified technical assistance. Extension services in many countries are still mainly and traditionally oriented at small rural farmers and the promotion of (integrated) and extensively managed fish ponds that are based on the use of local species and on-farm wastes. Coupled with often bad local transport infrastructure constraining market access, quantities of fish that are put on the market are generally low (Brummet and Rana, 2010).

**What type of aquaculture and for whom?**

The question of how best to manage the aquaculture sector is quite complicated. Apart from overcoming constraints and challenges, as further described in the following chapters, in general, a clearer **vision regarding the desired development of aquaculture** (what function is aquaculture to play in the realization of various policy goals) is needed.

There is a recent and general tendency to agree on the failure of aquaculture development for poverty alleviation (SARNISSA discussions forum, June 2010; see also NEPAD-PAF and FAO-SPADA recent strategies for aquaculture) and to shift the main focus to the promotion of (small- and medium-scale) commercial aquaculture. Although total production of small-holder aquaculture is low (though can be improved through participatory on-farm research and extension), and had not lead to significant growth in national production, it has proven that it can be a viable option to improve livelihoods of poor smallholders. Apart from contributing to household food security, the expansion of aquaculture is important in providing water during the dry season (or drought periods) to grow crops. By recycling of crop and animal wastes in aquaculture the entire farm system becomes more efficient (Beveridge et al., 2010; Brummet and Rana, 2010). It is therefore imperative to answer the questions if aquaculture in Africa should only be seen as a modern business, which should be developed strictly for its commercial success? Or is there still a place for small-scale local development to meet the nutritional needs of families, improving efficiency of their farming system and increasing their resilience, without putting much money in their pockets?

While it is good to critically evaluate aquaculture interventions made in the past, there is equal danger of promoting a unilateral focus on more commercial forms of aquaculture. All forms of aquaculture (for household food security, for local income and market production, and for export) may have their value, depending on why, how, where and for whom they are promoted. For household food security to be achieved, subsidized support to subsistence oriented farming is a long-term, but worthwhile investment. If a government targets economic growth, small and medium scale enterprises need to be supported to grow to sufficient scale. This will probably mean that the poorest farmers cannot be directly targeted, but will in the longer-run benefit from cheaper food on the market or labour opportunities in the aquaculture value chain (Brummet and Rana, 2010). Governments faced with low budgets and limited staff ability should better prioritise and design their interventions. What is, however, still lacking in most (if not all) aquaculture strategy documents, plans and guidelines is that no clear distinction is made among; (a) which type of aquaculture to support to achieve different policy goals; (b) which type of aquaculture to support, where in the country and for which fish farmers?; and (c) what interventions are needed to support specific types of aquaculture? It is for this reason that it is also difficult to monitor and evaluate the real impacts and cost-benefits of various types of aquaculture production systems.

What is needed are better defined **objectives** (with targets for the expected results in a certain time period) and **target beneficiaries** (who are intended to benefit from this policy). These should be translated in a better and **well selected mix of policy and support measures/instruments** to realize these objectives and a clearly defined **institutional framework and sources of financing** for the sustainable implementation, and monitoring of the policy or programme. Discussions on the recent Kenyan fish farming programme illustrate the importance of these issues.
Fish farming project stalled over lack of fingerlings

“Lack of fingerlings is delaying the establishment of fish ponds under a KES 22 billion (USD 283 million) government stimulus plan, aimed at creating 120,000 new jobs. Fisheries minister Paul Otuoma said that his ministry has a shortage of about 24 million certified tilapia and catfish fingerlings to support the fish farming plan. "Breeding of good and quality fingerlings requires time and that is why we seem to be moving slowly, but it's our hope that we will complete the project as planned," the fisheries development minister said. Otuoma said he is banking on the government-run Kenya Marine and Fisheries Research Institute to ensure quality fingerlings are sold to farmers.

The farming project is also grappling with lack of fish food. "We are working with various companies that deal in feed production to ensure that they adhere to the required standards," he said. Private players such as Dominion and other 25 manufacturers have been brought on board to ensure that there are enough fingerlings and commercial fish feed to meet demand. The current capacity of fish feed in the market is 14,000 metric tonnes; the ministry, however, requires about 100,000 metric tonnes in the months to come" (Adapted from: Worldnews, Kenya, May 05, 2010, http://www.fis.com/fis/worldnews/worldnews.asp?monthyear=&day=5&id=36452&l=e&special=&ndb=1%20target

In response to this article, Dr. Harrison Charo-Karisa, National Chairman Aquaculture Development Working Group/ESP Secretariat & Program Coordinator Aquaculture, Kenya Marine and Fisheries Research Institute however commented (SARNISSA Forum, May 07-2010): “It is not true that we are lacking fingerlings in the Kenya and it is not that Kenya did not plan for this ambitious program. The problem is one of logistics, fingerlings have to be transported over vast remote parts of the country where the ponds are being dug. This requires transport and due to impassableness of some of the roads due to the heavy rains the fish cannot be delivered on time. Therefore this is not about shortage or poor planning as some may suppose”.

It is questionable whether the required level of production to produce the over 24 million tilapia fingerlings can be achieved before or during the project period. Also, considering transportation problems, costs of fry and fingerlings may still be prohibitive to poor farmers to continue stocking their ponds once government subsidies run out. Similarly, and even if the quality feed is available, will lower-income farmers still be able to make profit by feeding their quality feed produced by private companies?

Above is 2kg Orechromis mossambicus broodfish (South Africa, August 2009). Experience over the last 30 years in both Africa and South Asia has shown that for sustainable development of the inland fish farming sector, fry and fingerling production should best be undertaken by the private sector. However, as well illustrated in countries like Thailand and Vietnam, the National Fisheries Departments can fulfil very effectively the maintenance and development of National Broodstock Centres. Here through breeding programmes both existing species can be improved as well as other potentially new indigenous species can be developed for aquaculture whilst leaving the production of fingerlings to meet the country’s fish farmers’ needs to the commercial private sector who historically are far better suited to fulfil this role.
4. Constraints and success factors for aquaculture development

This chapter illustrates some of the (commonly known) constraints and success factors related to production, processing and marketing of aquaculture. General issues relate to unavailability or high prices of good quality inputs (and more specifically feed and seed), inadequate knowledge of, and access to technology and technical assistance, poor market access, lack of access to financing and inappropriate policies. Potentials for development lay in strengthening farmer organizations, exploring niche products and promoting public-private and multi-stakeholder partnerships. Though the key issues mentioned have not been clustered for different types of aquaculture production systems, it should be noted again that, depending on the system to be promoted, specific interventions and support measures will be needed. Use of fish feeds that can be grown locally (using on-farm wastes) are key for subsistence-oriented farms, as these producers can not generally afford to buy feeds on the market. Training and technical assistance in best feeding and breeding practices and water management and fertilization should be adapted to their specific needs. For small- and medium-scale aquaculture enterprises, access to financing and markets and related business planning becomes more crucial, as will be the presence of a local feeding and hatchery industry producing quality feed and fingerlings. In response to the constraints mentioned above, large-scale commercial farms have tended to become vertically integrated systems. They can, however, benefit from specific support to explore niche products and markets or a larger-scale pelleted feed industry.

Access to quality feed

Good quality, affordable and accessible inputs such as fish seed and feed are the main components for successful aquaculture farms and projects. Feeds are an essential input, especially for more intensive production systems such as cages or tanks. Commercial fish feeds are in most cases not readily available (or are prohibitively expensive), and use of homemade/on farm formulas are extremely varied in their nutritional value, thus affecting growth rate of the fish stock.

The absence of a substantial national fish feed industry is a major constraint because:
- irrespective of the quality of fish species or strain, water and feed quality is a major determining factor of fish farm productivity;
- high cost of imported feeds negatively affects profit margins.

Salmon production in Madagascar too dependent on imported feeds

In Madagascar, there is a recent effort, supported by the Polish government, to introduce the production of salmon. This introduction was successful, but brought with it dependence on the import of expensive feeds from Poland. This reduced the feasibility of the sector and may motivate research on feed composition using local resources (Ranaivoson, 2009 p.21).

Key issues to work on include: alternative protein/ingredient sources that can be grown locally, least cost feed formulations; feeds adapted for local systems (Brummett and Rana, 2010), development of sustainable integrated farming systems or, alternatively, specialist high-performing feed sources.

More research could be done to identify and develop homemade formulas for fish feed to use in more extensive aquaculture systems as alternatives to commercial feed, preferably using readily obtainable local agricultural processing by-products. In Ghana, the Water Research Institute, together with the Animal Research Institute, has developed fish feed from agro-industrial products. Small and medium-scale farmers have adopted the formulations for use on-farm. In Cameroon good progress was made in feed production using locally available resources.

Integrating aquaculture within agricultural production (integrating fish and livestock, rice-fish systems) is promoted in Malawi, Zambia, Ghana and Cameroon. It is argued that in these systems the problem of lack of good quality fish feed can be reduced by using waste from livestock and crop production to feed the fish.

An example of integrated farming in Malawi

Hangere integrated farm is located in Mzuzu City, the Mzimba District in Malawi. The farm has established aquaculture (Tilapia rendalli and Oreochromis karongae in polyculture with Clarias gariepinus in monoculture), with the fish ponds located next to maize, sweet potato and vegetable cultivation. Pigs, goats and dairy herd are also kept. The fry are fed on a crushed maize bran powder incorporated with other on farm ingredients into a formulated diet. Livestock manure is used to fertilise the ponds to boost primary production. The farm faces challenges including labour shortages, absence of a hatchery for fingerling production and lack of extension services. Low water levels in the hot and dry season and pest-infestation in the ponds reduces production (Kamtambe et al., 2009).
However, it is important to not only consider the technical issues, but also competition for alternative uses of available by-products (as animal fodder or a source of energy supply). In Cameroon for example, IRAD has carried out a programme on how agricultural by-products can be used as fish feed. However, the farmers often already have other (more important?) uses for these by-products and they are thus not available as a feed resource for fish (Tangou, 2009, p.20).

For more intensive production systems, homemade formulas may, however, not suffice. In South Africa, aquaculture is greatly benefiting from the well-established agriculture industry and related commercial animal feed sector existing in the country. The agriculture industry provides a wide range of raw materials and by-products that can be used in the formulation of aqua-feeds. A number of companies have started to produce specialist aqua-feeds for both the freshwater and marine sectors. Specific feed formulations are available for all cultured species. For abalone, the country has developed a highly specialist feed that is now exported to other abalone-producing countries.

For other intensive aquaculture systems, extruded floating pellets are needed, and action-research could focus on setting up locally-made machines to produce such feeds. The commercial sectors in both Uganda and Kenya have, in 2009 and 2010, through interventions and support of the USAID CRSP programme (http://aquafishcrsp.oregonstate.edu/), developed their own commercial private sector feed mills producing floating (extruded) pellets for aquaculture development, especially the nascent cage culture production systems. Although these two companies are still in the early years of developing their feed production, the availability of floating fish feeds is a significant step towards creating viable aquaculture industries in these two countries.

**Quality fish seed and fingerlings**

Apart from fish feed, availability of good quality and reasonably priced fish seed or fingerlings is stated as another significant problem. Most of the fish being grown on fish farms in developing countries are of poor genotypic or phenotypic quality. Erratic demand also hindered the development of a private hatchery sector, while the many large-scale government hatcheries and associated research stations that have been built over the years have nearly all failed to achieve sustainability, mostly due to poor management and budgetary constraints; or simply because they were never set up or run to operate on a commercial basis (Brummett and Rana, 2010). The absence of fish hatcheries leads to:

- sub-optimal use of culture facilities, because of insufficient quality, quantity and timely supply of seed and fingerlings;
- prohibitively high prices for fingerlings and seed;
- limited diversity and lack of locally adapted species;
- use of wild caught or increasingly inbred, stunted stock from farmers own ponds or those of their neighbours.
Key issues to look into include: **best species selection and size at stocking, quality issues, broodstock management** (Brummett and Rana, 2010) and **setting up of local and self-sustaining nurseries and hatcheries**.

Selection of appropriate species to local conditions may be a challenge. African catfish (*Clarias gariepinus*) can be stocked at high densities and is easy to manage in small ponds. However, it requires a high-protein/meat based diet and availability of on-farm feed may be limited. Other fish species (such as cultured tilapia) are more prone to suffer (and thus show low performances) from bad hatchery management than others.

Small-scale nurseries and hatcheries can not only constitute successful businesses, but can also function as nuclei for other aquaculture farms nearby. Local hatcheries, feed producing units and markets should be profit oriented, so that they will continue to carry on even after initial project or credit (loan) support has ended. In Thailand, the Thai Department of Fisheries for example has a policy that all their extension offices and stations have to run as income generating commercial units. The stations generate income through sale of fry, fingerlings and fish, next to offering free technological advice and extension (Bhujel, 2010).

**Access to information and other inputs**

Availability of information is another constraint in many countries. A catalogue of the major input suppliers to commercial fish farmers in a country, such as **The Uganda Commercial Fish Farmers Inputs and Services Guide** could be of great help.

Furthermore, knowledge about design, construction and hatchery equipment and other accessories needed for certain types of aquaculture, for example, pumps, aerators, cages, hapas, tanks, hatching jars and incubators or cribs, is hard to obtain in most countries. Easy-to-follow manuals for various types of installations would help farmers become established, as would the dissemination of available information and the organization of farmer-to-farmer exchanges on topics such as broodstock management, business development, quality control and optimum stocking practices.

Left: Information needs are changing: new publications beginning to emphasize the importance of business development (Uganda, May 2009) Right: Nairobi commercial agricultural supplier now beginning to sell aquaculture equipment and inputs mostly imported from China (2010). The image shows Chinese plastic pond liners which are increasingly being used to build ponds in poor soil areas across Kenya. Kenyan traders and fish farmers often complain of excessive administrative, bureaucratic and financial constraints in bringing in much needed aquaculture equipment to develop their industry. Apart from private sector response, for example in Malawi, a recent Presidential Initiative on Aquaculture Development (PIAD) document states that the government would be prioritizing the easier flow of imported aquaculture supplies and equipment into the country.

**Technical assistance**

Due primarily to low levels of investment, aquaculture research and extension services are weak in most countries in SSA. It is very difficult for smallholder farmers to get up-to-date information about locally appropriate and improved technologies and management practices, legislation, marketing opportunities and strategies, etc. It is up for discussion whether the solution lies in more government extension, more private sector involvement (that is still often operating at a level too low to bear such additional costs) or better outreach from research institutes (see also Chapter 5).

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2 The SARNISSA network now has made a vast library of online aquaculture materials, publications, information and contacts available to over 1500 registered members across borders and languages.
Key issues include the need for **high quality technical assistance supporting smallholders and entrepreneurs over a reasonable time** and **practical and locally adapted technology packages and business plans that respond to the need of specific types of farmers.**

Most aquaculture research, development and extension systems as described in the SARNISSA case studies, however, still apply an approach of “transfer of technology” to farmers. Generally, producers have little or no say in the choice of techniques to be researched and developed (and often technologies promoted are not adapted to the local context and know-how). The technology is generated on research stations (which are not run on a commercial, for-profit basis) and not on individual private farms, and knowledge transmission to local farmers is mainly top-down. This is one of the main reasons for the high abandonment of ponds, dugouts and cages in reservoirs after projects have finished. From the SARNISSA cases it is clear that other approaches, such as participatory research and extension and a focus on socio-economic, technical and organizational innovations are very much needed in order to achieve better results and improve rates of technology adaptation and adoption. These three types of innovations cannot be considered separately; but instead they must be seen as parts of an integrated system. It is acknowledged that research in aquaculture is not always sufficiently geared towards ensuring commercial viability of aquaculture or benefits to end users. Therefore, more action-research is needed for which the research agenda should be identified, discussed and prioritized by researchers in close interaction with farmers (ETC Foundation, BUNDA and IRAD, 2009).

Apart from being adapted to local needs and situations, technical assistance should be sustained over a longer time, as most small businesses take 3-5 years after their first production cycle to start earning money (personal communication Brummett, 17 June 2010). Supporting commercially oriented farmers in market analyses, business planning and profitability analyses will be important. This includes accurate and up-to-date record keeping on performance of their systems. A basic but clear understanding of profit and loss, cost benefit analyses and regular monitoring of how their farms (businesses) are operating will provide farmers with the data and tools to make beneficial alterations and modifications to farm management that will help increase efficiency and thus the commercial viability of their businesses.

Encouraging small-scale cage culture and training farmers in cage construction in Nigeria (see also: http://allafrica.com/stories/201008090038.html or http://www.youtube.com/watch?v=a-9yZLO6so)

**Importance of farmer organizations**

The presence of well-functioning fish farmers' associations can be considered another factor contributing to aquaculture development. For individual farmers it can be very difficult to obtain inputs such as quality fingerlings and reasonably priced good quality feed. Marketing can also be easier when undertaken as a group. Farmers' organizations can also play a role in ensuring farmers' voices are better heard in defining research agendas and in national policy making. The establishment and strengthening of farmer organizations also improve dialogue and exchange among producers and enables them to better share their successes and failures, techniques and innovations on subjects such as choice of fish species, feeding and nutrition and farm management. Unfortunately, past experience in SSA has shown that it is often difficult for small-scale producers' associations or co-operatives to maintain and run their organization independent of outside funders' support and finance. Even where farmers' organizations exist, many members do not actively participate, and only a few represent the whole group. Representativeness, legitimacy, and trust among members, are crucial to the functioning of an association.
Strengthening producers associations would be an important strategy for aquaculture. However, the SARNISSA studies, do not report strong farmer organizations playing a crucial role in sector development except in countries like South Africa and Uganda. For example in South Africa, the Aquaculture Association of South Africa AASA (now recently changed to the Aquaculture Association of Southern Africa) has been active since the late 1980’s and along with a bi-annual conference for its 150+ members offers a number of benefits and networking opportunities. Within this overall umbrella organization there are eleven sub-sector associations, representing the different species and regions. In Uganda, and through the USAID CRSP project, the Walimi Fish Farmers’ Co-operative was set up in 2004 and now has over 300 members paying dues and also being able to buy shares in the Co-operative. The organization has an office in Kampala where the fish farmers can go to both sell their fish and also buy fish feed or arrange to buy fingerlings from a central, easily accessible location. The Co-operative has already held Two Annual Fish Farmers Symposia in Kampala where all the members meet for presentations and discussions and can visit an associated trade fair for aquaculture equipment and input suppliers. Although the Co-operative has its problems and challenges it has so far managed to provide many benefits for its members and can be a good role model or yardstick for others wishing to develop Fish Farmers’ Associations in other countries. There are also some other examples of small groups of farmers owning individual ponds as in Cameroon, Uganda and Malawi, grouping together to purchase inputs, receive technical information, assist each other in labour activities and market the fish.

**Success of farmers’ organizations in Uganda and Malawi**

In Uganda, the favoured approach by the USAID Auburn University project now is to encourage individual farmers to form associations of independent fish farms. Through these associations, farmers pool resources to access technical services and training (through direct procurement themselves, as the association, access grants/donor support) and do collective marketing. Several fish farmers’ associations come under the umbrella of the National Farmers Federation. In this regard, the Uganda Cooperative Alliance has also established farmer clusters that operate as parish cooperative societies (Nathan, A. pers. comm. as mentioned in Isyagi et al., 2009 p.18). This is proving to be a more sustainable option. Walimi Fish Farmers Cooperative Society (WAFICOS) formed in 2004 is a successful case (Isyagi et al., 2009, p.10) as illustrated above.

In Malawi, The Zomba Fish Farmers Association was established in 2003, in six traditional areas in Zomba District. With the help of the National Aquaculture Centre, the association receives technical and extension support from the District Fisheries Office. (Mwale, 2009, p.19).

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Uganda WAFICOS Fish Farmers Co-operative: The Kampala Office Providing services for its members: marketing their fish and also providing them with central outlet to buy fish feed. Contact Lovein Kobusingye (waficos08@yahoo.com) for further details.
In Madagascar, associations of smallholder farmers were formed around private broodstock producers, as an off-shoot of an FAO farmer-to-farmer extension project. In Bandundu province, in the Democratic Republic of Congo, 28 fish farmer associations representing 900 fish farmers were formed in the context of a Peace Corps family fish farming project. In Benin, a national network of fish farmers (RENAPIB) was formed in 2009. In Ivory Coast, and in order to vitalize the aquaculture sector and augment national production, a national association of aquaculture stakeholders (individual producers, cooperatives and societies) was formed in early 2010 and named ANAQUACI (The National Association of Aquaculture producers in Ivory Coast). APDRA the French NGO working in aquaculture development is currently supporting the establishment of a network of fish farmers in the Central and Western regions of Cameroon under the National Association of Fish-farmers in Cameroon AQUACAM. Cases of formal associations acting as a recognised partner for the government in setting research agendas and in policy development are, however, still rare.

Processing and marketing
Marketing is an important factor in determining success or failure of an enterprise or project. The bait market for Lake fishing for example boosted the development of several Clarias hatcheries in Uganda. Marketing prices obtained for fish and derivatives are critical for commercial farmers and are influenced by market demand, quality of produce, and continuity of supply and product perception.

Efficient marketing is often hampered by:

- Distance to market,
- Poor infrastructure conditions/high transport costs, constraining especially small and medium scale and even some larger-scale systems,
- Security situation in certain countries or that affect the whole region. For example, in 2008, catfish fingerling production in Uganda dropped by half, largely due to insecurity in Kenya that affected the flow of imported goods and services from the Kenyan port of Mombasa to Uganda,
- Low local demand; due to transport difficulties, fish often has to be marketed mainly locally, where demand may be more limited, and prices may be lower,
- Fluctuating prices and farmers’ lack of information on prices and market buyers,
- Lack of market information and information on consumer preferences (though increasing access to coverage and use of mobile phones throughout SSA, even in rural areas, is now beginning to redress this balance),
- Insufficient quality standards (for certain markets or for export) and unsanitary marketing conditions,
- Previous absence of any form of product branding, although this is now beginning to change with the emergence of commercial producers selling directly into retail and supermarket sector,
- Difficulties of reaching high-end consumers for smaller and individual producers. High class hotels, the tourism industry and larger supermarket chains are often catered for by large-scale commercial farms, whilst the small-scale farms due to the nature of their more seasonal production cycles can only access more traditional district and regional level town and city wholesale and retail markets,
- Absence of storage facilities (e.g. ice),
- Competition from international markets: otherwise sound initiatives can fail through changing global circumstances, such as low world market prices. In combination with other sub-optimal factors, such as changing macro-economic circumstances, this may prove fatal for farming activities,
- Limitations caused by EU regulations regarding fish and fish product imports from African countries (Desprez, 2009, p.17),
- Competition in the market from cheap, imported, Asian frozen fish (Desprez, 2009, p.16).

Shrimp marketing in Madagascar & South Africa: Macro-economic changes curve the trend

In Madagascar, nearly 90 small-scale entrepreneurs went into shrimp production during the years 2000 and 2001. A system of satellite farms of small-scale shrimp producers was formed around the industrial producers and stimulated by the government. In the start up phase, they enjoyed certain preferences such as access to cheap inputs and guaranteed prices. Ultimately, these small-scale producers did not survive because soon after they had started, the world market price of shrimps collapsed, the quality they produced did not meet the export standard and low profitability forced them out of business (Ranaivoson, 2009, p.41).

Note: in 2010 Kenyan and Ugandan Governments under their Aquaculture Development strategies are building or renovating upwards of 40 new or existing cold stores in regional locations throughout the two countries. See from Uganda media: Fred Musiga Ugandan Fisheries Minister (http://www.newvision.co.ug/D/8/220/727009)
Also in South Africa, two shrimp producers abandoned production, because they could not compete with imported prawns, due to cost and price considerations primarily because of geographical location they were not able to complete a minimum of two production cycles / crops per year (Shipton et al., 2009, p.iv and see Amatikulu Shrimp Case Study available on SARNISSA at \texttt{http://www.sarnissa.org/tiki-index.php?page=SARNISSA++Project+Publications} and the Aquaculture Compendium \texttt{http://www.cabi.org/ac}).

Key issues include: \textbf{selection of (hardy) fish species, fish preservation, market diversification, market development and promotion (including better market and price information)}.

Since fresh fish has an extremely short “shelf-life”, facilities for preservation would help farmers to become more flexible in their marketing. Unfortunately, equipment to preserve and store fish is relatively expensive, and conditions under which fish are handled, processed, sold and transported often cannot meet hygienic standards without refrigeration. In contrast to this, however, the durability and ability of live \textit{Clarias} and \textit{Heterobranchus} spp. to withstand sustained periods out of water has greatly complimented the handling, marketing and sale of a fresh product within the Nigerian catfish industry. Amongst this marketing sector there is also a well developed fish smoking sub-sector. This has meant that the Nigerian catfish marketing chain has been able to develop with far less of a dependence on widely located cold store facilities within the main wholesale and retail fish markets.

Market diversification is also important. In Kenya and South Africa, for example, trout farming is practised by relatively small family-owned operations. Trout for the table fish market is primarily marketed either directly to consumers, wholesalers, restaurants and hotels, or to the processors for value addition. Fry are sold to stock dams (as in Lesotho) for the commercial fly-fishing industry. Processing companies produce approximately 40 different value added products to the restaurant and high end markets. In South Africa, supply is insufficient to meet demands.

Market development (including transport and communication infrastructure) and improving product image can help increase profitability. As Shipton et al. state: "While the culture technology for \textit{Clarias gariepinus} (catfish) farming is well-developed, marketing remains a constraint in South Africa. Despite two waves of investment in catfish farming, many producers have left the sector due to poor local markets for catfish and poor product image. While this could potentially change in future, realistically, only a massive and successful marketing campaign to improve product perception could change this situation" (Shipton et al., 2009, p.12). Market development (including improvement of transport and infrastructure) should, however, accompany technological improvements, improving management capacities, training and support on business planning, quality control, market diversification and support to producer organizations. Availability of better and up-to-date information on fish retail prices and consumer requirements and demand will also enhance marketing by specifically small- and medium-scale producers.

Developing market infrastructure and promoting your producer. Tilapia producer, Ghana (January 2010).
Access to credit and financing
In all countries, access to credit is very limited. Even if credit is provided to aquaculture producers (which is often not the case as banks consider aquaculture in SSA a high risk investment), the high costs of credit inhibit access of farmers to funding. Unfortunately, this is true for both small- and large-scale aquaculture. Despite the past message given from previous subsistence-, poverty alleviation-based aquaculture development programmes/national strategies in the last 30 years, most fish farming ventures require relatively significant initial levels of investment irrespective of scale, for example, for proper pond construction or cage and tank building, and initial outlay on inputs such as feed. Besides credit for investments, money is needed to cover operational costs, such as buying good quality feeds (often up to 50% or more of total operational costs) and fingerlings.

Small-scale farmers do not have good collateral (such as savings in a bank, or assets in terms of property or ownership of land). New farms and new infrastructure are thus principally only available to wealthier farmers, or through projects. However, as long as these projects do not build farmers’ capacity to manage loan schemes, to keep records, stock inventories and awareness of cash flows and cost benefit analyses, even at very rudimentary levels, then they will be unlikely to calculate and demonstrate profit or loss. Also, often, lack of maintaining savings for repair and maintenance costs and for new investments, are almost certain to cause new farms and infrastructure to fall into disuse after a short time.

Key issues include thinking and testing of new financing mechanisms and sustaining financing through development of business planning (and market analysis) skills.

As in the agricultural sector, group savings and credit schemes or combinations of (project or government) subsidies, producer savings and (bank) credits could be explored, to make both longer-term funding for infrastructure as well as short-term funding for working capital available to farmers. Similarly, new forms of value chain financing, including guarantee funding, could also be used in aquaculture farming. With the availability of such funding mechanisms, farmers will for example be able to invest in equipment, such as cages, for well-chosen aquaculture ventures. It is particularly important, however, that potential investments are thoroughly evaluated (e.g. through forms of business planning), in order to avoid future disappointments and investments that lack a viable economic basis. Training in business planning and financial management should be an inherent part of any funding mechanism.

Exploring niche products
There are opportunities for alternative species to those that currently dominate commercial aquaculture production in the region. Producing ornamental fish, for example, seems to be a profitable niche. In Malawi, they are caught in the wild, packed and exported to Europe, Japan and the USA. In South Africa, two large farms produce ornamental fish for the domestic market as the high costs of airline freights (compared to that operating in Asia, for example) make export less profitable to them.

Ornamental fish production in South Africa

The culture of ornamental fish and aquatic plants for the aquarium trade has a long history in South Africa. For many years the industry was dominated by hobbyists and backyard operators. However, recent years have seen a shift in focus to more established commercial farms that specialise in bulk production for the domestic market. There is currently one ornamental farm in South Africa producing over 20 tonnes/year., and another producing between 5 and 20 tonnes/year. The remaining small-scale commercial farms all produce between 0.1 and 1.2 tonnes of ornamental fish per year, and production is generally shipped to a central point, from where it is marketed (a form of satellite farming). Ornamental fish farming is currently undertaken in all provinces in South Africa (Shipton et al., 2009, p.13).

Ornamentals can be a viable alternative because they have high value per unit weight (minimizing transport costs) and do not need a lot of feed to be produced in commercial quantities (compared with fish for consumption). There is a great potential for the following fish species to become more widely available in the international aquarium trade: cichlids from Lake Victoria; dwarf cichlids from Cameroon (Pelvicachromis spp and many others) as well as other countries in West Africa such as Liberia, Nigeria, Sierra Leone, Ghana, Guinea etc.; the Synodontis catfishes of the Congo system. New production and marketing systems should consider the development of a satellite system of small breeders coupled to a central exporting facility, as operates in Asia and the Amazon basin in South America with great success (personal communication N. James, 25-02-2010). Local market demand should however also be explored. Seaweed (as produced in Madagascar, Kenya, Tanzania and South Africa) or other cultivated edible aquatic plants (widespread in Asia) such as morning glory and water mimosa grown in large weights often recycling urban waste water in and around the South Asian cities of Hanoi and Ho Chi Minh City (Vietnam) and Phnom Penh (Cambodia) are other potential new developments in the African aquaculture sector, which could prove viable options in some areas.
Production in and around cities facilitates the use and testing of new technologies and species, such as tanks, raceways and recirculation systems. This is particularly evident with the Nigerian *Clarias* concrete tank industry being closely located within peri-urban conurbations in the midst of large urban market demand in the likes of Lagos and Abuja. In South Africa, koi carp is produced by a large number of small “backyard” producers in urban areas. It is fairly easy to adopt and it could be an interesting activity in other countries, where climatic conditions allow.

Niche products and markets, including those for ornamental fish, aquaculture plants and organically certified aquaculture, however, have not been widely explored. Research could help identify the most suitable species, production methods and marketing systems. This would require further research on fundamental biology, fecundity, growth rate, and sex ratios of alternative and possibly more profitable fish species. Care must be taken, however, with the introduction of exotic species that could threaten local biodiversity and introduce diseases. Production potential, consumer preference and genetic management of these species are often lower and more complicated than initially estimated. For certain researchers, fish farmers, and other stakeholders, there is the strong view that there is already a sufficient local genetic base of tilapia and catfish within Africa to continue using indigenous species for aquaculture, rather than bringing in new, “alien” species, with all of the inherent implications/risks of biodiversity and disease (personal communication R. Brummett, 26-01-2010).

**Benefits of multi-stakeholder conglomerates and public-private partnerships**

Experience in Madagascar has shown that a conglomerate of government, commercial sector, research institutes and farmers’ organizations can be a very powerful mechanism to ensure the availability of crucial inputs to farmers, develop new research (on niche markets and new or improved technologies) and enhance farmers’ technical skills. Based on examples from countries such as Madagascar, Uganda and Ghana⁴, where such conglomerates are already functioning, other countries can develop their own models, like the reference centres and Research Extension Teams (tested in Cameroon) as mentioned by Desprez (Desprez, 2009, p.14). In such partnership models, financial institutions, for example, can help safeguard the economic viability of business plans, collaborate in the creation of (micro-)credit schemes (while governments may provide the needed guaranteed funds) and, in collaboration with training institutes, train farmers in business/financial management. The input supply industry can develop various alternatives for feed and seed production; commercial hatcheries could work with satellite farms providing training and technology, etc.

Multi-stakeholder collaboration and public-private partnerships can thus enhance technology development and promote research that is relevant to the local context, responds to farmers’ needs and builds on locally available knowledge and resources. Apart from sophisticated technologies for commercial farming, the availability of and access to low-tech and locally appropriate production methods was identified by the SARNISSA studies as an important factor for success of small-scale aquaculture, resulting in high adoption rates and post-project sustainability. Coordination and support of such multi-stakeholder conglomerates may be the responsibility of national governments.

**Roles of government and other actors**

Aquaculture production in SSA is constrained by various factors, the most important ones being: lack of (quality) inputs, including good feed and seed, lack of high quality technical assistance, training and information, and limited access to credit and good markets. Additional development needs for the sector include:

- the presence of agriculture industry with by-products and the availability of local feed industries and hatcheries,
- development of market infrastructure and product image,
- farmer organization, improved knowledge exchange and information sharing among farmers,
- new forms of financing and related business planning
- development of niche production systems (such as ornamentals, aquatic plant cultivation and seaweeds).

The presence of conglomerates of stakeholders that collaborate in the development of new projects and approaches, and involve farmers and strong farmers’ associations in applied and on-farm research, project design, development and evaluation, may spur aquaculture development even further.

Adequate and coherent research and policy interventions are needed to help solve these constraints or make optimum use of existing resources. The development of extensive, subsistence-oriented production systems requires locally appropriate technologies, locally and least-cost available feed sources and supporting agencies and funders who motivated to provide longer-term support. Selection of most-promising, committed (and nucleus) farming households will be more effective than trying to reach out to hundreds or thousands of farmers, without any specific selection criteria.

Commercial aquaculture requires development of an industry sector with associated equipment and input suppliers and

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⁴ In Ghana and Uganda, Commercial Aquaculture Producers of Africa (CAPA) ([http://www.aqua.stir.ac.uk/development/CAPA/](http://www.aqua.stir.ac.uk/development/CAPA/)) provides technical assistance on feed and fish technology to a group of commercial farms. Through this approach, a cluster of small and medium farmers get fingerlings, feed and advice.
support services. Generally, an industry has a greater chance of sustainability if it is private sector-led. Public or donor funds can help to offset the initial risk associated with a new industry (for example, supporting partial cost of equipment or reducing taxes on imported aquaculture inputs and ensuring their free flow through customs), while maximizing benefits for society and minimizing possible negative environmental impacts. Governments need to facilitate development by creating a private sector-friendly environment, for example, by simplification of environmental impact assessments, reduction of government harassment and tax- or duty-related incentives for investment (Brummett and Rana, 2010).

Government investment should also include development of the support systems, such as research and extension. Government, through universities and the private sector, can also support research aimed at “growing the right species using the right technologies in the right place” (Beveridge, 2010). These and other issues related to aquaculture research and policy making will be discussed in the next two chapters.
5. Education, training, research and extension

Investment in training, capacity building, research and extension is needed with a view to enhancing the profitability and sustainability of aquaculture production systems. Characteristics of the current education and training offered in the ten country studies are briefly described below, followed by a discussion on challenges for aquaculture research and extension in SSA. As indicated in the previous chapter and resulting from SARNISSSA and partner consultations aimed at prioritizing research to increase its impact, general research needs to relate to the following five general themes; feed, seed, markets, technology and policy. More importantly however, research, training and extension needs to be more action-oriented and locally relevant, prioritizing real needs of farmers and prioritizing farm-level impacts over scientific publications (Brummett and Rana, 2010). Research can furthermore play a role in informing improved policy-making on aquaculture, by providing good baseline studies, helping to effectively monitor policies and programmes and applying new forms of networking and dialogue between researchers and policymakers.

Education and training

All ten country reports mention the presence of educational and training institutes with special programmes related to aquaculture at Diploma, BSc, MSc and/or Ph.D. level. Some have a long tradition in aquaculture studies, others are more recently established. The programmes cover general aspects of Aquaculture and Fisheries, Aquaculture Technology, Fisheries Science and Management, Aquatic Resource Management, or more specific subjects, such as Fish Nutrition or Fish Breeding. In addition to full length academic programmes, short (e.g. several-week to 3-month) courses for professionals may also be offered. In some countries Vocational Training Institutes exist, offering pre-service and in-service training for technical staff and special courses for farmers, for example, in Kenya:

Vocational training at Ramogi Institute of Advanced Technology (RIAT), Kenya:

The Ramogi Institute was established in 1976 with the purpose of:

- Providing technical level (craft, certificate and diploma level with technical attachments) and community-based training,
- Offering tailor-made courses to meet specific demand,
- Providing close linkages with the main Government institutions, i.e. Departments of Fisheries and Research Institutes,
- Capacity building through ongoing vocational pre-service and in-service training delivery for future or serving technical staff in fish processing industry, fish farms, government departments and development agencies (Ngugi and Manyala, 2009 p.35).

In most cases fishery departments within the educational and training institutes are quite small. The programmes do not attract many students, not least because the aquaculture sector is relatively small in the countries involved. Student numbers and educational standards vary between countries. Moi University in Kenya was one of the first institutes in the region to offer courses on aquaculture and is now able to attract 40-50 students per year. Little information can be found on the number of female students that enrol in aquaculture studies, although Bunda College in Malawi reports between 25-30% of their graduates to be female. The total number of students is 15 to 20, graduating annually from its Bachelor of Science programme in aquaculture. For Ghana, similar figures (about one-in-four students being female) are reported.

Aquaculture training and education is still notably still underrepresented, reflecting a bias towards other agricultural and livestock products. Even if aquaculture is offered, little attention is given to aquaculture extension and practical expertise, for example, training individuals who can manage commercial hatcheries or growout farms (Nigeria national aquaculture strategy, 2008). This is in contrast to certain countries in Asia, where master’s degree programmes on aquaculture are offered by various universities, like the Institute of Agriculture and Animal Sciences in Nepal, Bangladesh Agricultural University and the Asian Institute of Technology in Thailand. Increasingly, these programmes seek to train graduates in such a way that they can also establish their own farms or businesses, by providing practical internship programmes, carrying out on-station research and research trials on actual commercial or private fish farms rather than in university or government research stations. The Aquaculture Masters degree courses at the Asian Institute of Technology in Bangkok, Thailand, for example, include 6-month components where students, as part of their courses, have to run cycles of tilapia fry production on a commercial basis and sell the fingerlings on to farmers. The hatchery at AIT is overall run and managed on a commercial basis so that it covers all of its running costs and even makes a small profit (Bhujel, 2010).

Key requirements for research and training institutes to play a more important role in aquaculture development include; the need for more practical (and on-farm) education and training, better monitoring of the uptake and effectiveness of training and education programmes, building staff capacities and improved dialogue and networking among researchers, policy makers and other stakeholders.
Many aquaculture training institutes, especially universities, however, still tend to offer theory-based material, detached from practice. Education and training could be better oriented to the requirements of the various jobs on offer, as well as to the needs and realities of farmers. Having their own experimental and demonstration facilities and being involved in extension and research networks is therefore of utmost importance to increase the relevance of the work of educational and training institutes. Some are already actively involved in conducting farming experiments, case studies and/or production of extension materials, such as the Malawi Fisheries College, that produces aquaculture extension materials for distribution to small-scale farmers. The college conducts residential training for small-scale farmers who are engaged or are interested in starting fish farming. Training is mostly sponsored by NGO’s. Little is known however of the uptake of such residential training, due to lack of monitoring, to be better able to judge whether the training programmes are really need-based, whether the right kind of trainees are selected and whether trainees apply their skills and knowledge afterwards.

Students that are trained by the college are ultimately employed by the government as Fisheries Assistants in the various government fisheries institutions and not actually into jobs working on fish farms or producing fish, a scenario typical across SSA countries. As a result, (overmanned) government departments often lack staff with any longer-term (field or commercial) experience in aquaculture. Again, there is a lack of monitoring tools that could be used here: such as the ratio (percentage) of government fisheries department employees compared to annual aquaculture production in the country or the total amount of fish produced per Euro spent by donors and national governments. Performance monitoring should not so much be individual-based but look at the efficiency and effectiveness of teaching and government programmes as a whole.

The institutes with practical facilities, such as a fish farm to carry out experiments or demonstrations, can have an advantage over those that do not. However, past experience over the last 20-30 years across Africa continually shows that such university and research institute fish farms will only be effective if they are run and managed on a commercial basis, thus, again, not continually relying on outside (project) funding to cover their daily running costs. If not, even despite initial large funding inputs to construct state of the art facilities and training of staff, these farms will inevitably run into budgetary problems. The same analysis and conclusions can, unfortunately, also be drawn for government run research and demonstration farms and stations.

Some institutes do pay a lot of attention to building staff capacities. This is done through internal training, but also by participating in regional projects. In some cases teaching staff have studied abroad and/or are taking part in consultancy assignments in other countries in the region, which is another effective way to increase staff expertise. Again, trainees should be motivated to apply their experience/knowledge gained by getting involved in actual aquaculture production processes, if possible, on private or larger commercial farms. Fish farm management could be made a compulsory course for current and future staff and trainees.

In addition, more structured partnerships among research institutes, governments, commercial farms and NGOs could be established, leading to more applied knowledge development and delivery (teaching/learning), as well as stimulating
applied research, where possible, on-farm with private farmers of different scales of production. Promising students can be proposed for sponsoring and internships giving them practical work experience in the private, government, or NGO sectors, thus enhancing the relevance of training and exchange.

**Challenges for aquaculture research**
Research needs to take better account of demands of end users (and policy makers). Key areas for research to meet this goal and ultimately to meet the overall objective of growing more fish, shellfish and other, aquatic products in Africa, as also indicated in Chapters 3 and 4, include:

- the development of high quality, cost effective feeds (either grown or provided locally, and adapted for local systems, applying least-cost feed formulations);
- development of on-farm and appropriate technologies, especially in the fields of breeding (broodstock management, stocking sizes) and feeding;
- profitability or viability of different aquaculture production systems across Africa and subsequent development of business plans;
- use of best (and niche) species;
- value-chain improvement and marketing.

While there is certainly research capacity to undertake this work (e.g. the nutritional research groups at Rhodes and Stellenbosch Universities in South Africa), there is currently limited funding for such activities. This is partly because aquaculture research has, over the past years, failed to show demonstrable impact on economic growth or fish supplies in markets (Brummett and Rana, 2010). Again, new partnerships may fill this gap, as shown by recent examples in both Uganda and Kenya where through USAID and Auburn University collaborating with existing in-country commercial feed producers, these companies are now producing and selling formulated floating fish feeds for the two countries’ fish farmers. A start could also be made by developing short illustrative case studies as pioneered by SARNISSA of different successful feeding projects highlighting what the project is about, what concrete impacts are and what potentials there are to upscale the experiences. It should be noted that such research should first and foremost build on past research and associated technology development as implemented over the past 40 years in order to make most efficient use of current and, in many cases, limited resources.

**The need for on-farm and participatory research and extension**
In order to allow for better technology adoption and adaptation, more on-farm and participatory research and extension is needed.

**Cameroon: Successful participatory approaches**
Partnership research or action research was explicitly tested as a new strategy in Cameroon. In this participatory research model, a scientist guides a learning process with farmers and extension workers and involves all stakeholders. Farmers in this case practised aquaculture- agriculture integration and many of them had earlier abandoned their fish farming activities. At the end of the action-research cycle, all relevant stakeholders discuss their findings and jointly decide which topics should be further researched. Good quality fingerlings, appropriate feed resources, technical assistance and cash for pond operations were identified as main problems. Two common initiative groups were formed and after working with the researchers in a full research cycle, lasting one and a half years, there was an average 2.5-fold increase in yields (V. Pouomogne et al.,2004). Other inspiring examples can be seen in the ATP CIROP project, which uses a participatory approach: using local knowledge and working in partnership with the producers, it shows examples of effective technologies, readily adopted by the producers (Tangou, 2009 p.32).

The new aquaculture development plan in Cameroon (Dec 2009) has decided to adopt the farmer-scientist research partnership approach of extension nationwide: though it appears more expensive to implement compared to the traditional top down system (in which researchers train extension workers who in turn train producers), pilot projects led by World Fish Centre, CIRAD and local NGOs revealed that outcomes are more sustainable. The approach valorises indigenous knowledge from the farmers, close and permanent communication between researcher, extension workers and producers. NGOs can be associated to the process in order to upscale the approach (personal communication V. Pouomogne, April 2010).

Participatory research and extension should also help farmers to identify problems and appropriate solutions. Heavy dependence on external inputs and a technology that is not flexible has a high risk of failure (Kaudjhis, 2009 p.25).
Ivory Coast: Success and limitations of participatory research

Where fish farmers have participated in all stages of the technology development success has been remarkable. The Project Appui à la Profession Piscicole du Centre-ouest (PPCO), for example, established construction and maintenance teams, which helped establish 418 installations, 719 fish ponds and 290 dams, producing an additional 90 tons of fish annually. Farmers participated in both pond development and in the marketing of the fish. Integration of fish production into rice cultivation was also taken up by the farmers, and spread even outside the project area. A comparable project to PPCO (PAPPE), in the east of Ivory Coast was less successful, because they did not involve the fish producers as actively. Another difference was that they opted for a more expensive species of fish (Kaudjhis, 2009 p. 23).

As well as in Cameroon and Ivory Coast, in Zambia and Kenya, various agencies have been successfully experimenting with new approaches to aquaculture extension. These new approaches have in common the direct involvement of farmers in the process of priority setting and choice of technology (Brummett and Pouomogne, 2004). In Kenya, the USAID supported Collaborative Research Support Programme (CRSP) resulted in technical improvement with a high degree of adoption. The strong points of this programme were the combination of academic research and a strong extension component of on-farm trials. Projects that have been successful have been stakeholder driven with local communities being involved from the start, and are characterized by elements of sustainability since they are embedded in core activities of the Ministry of Fisheries Development (Ngugi and Manyala, 2009 p.39).

As Brummett and Pouomogne mention: "An important fact to be taken into consideration, is that "quality extension" does not simply mean that extension officers have adequate technical training" (although even this is often lacking). Also important are social skills necessary to overcome cultural barriers and communicate effectively with farmers, even if uneducated and illiterate. Participatory research and extension approaches permit to engage in joint learning exercises that advance the knowledge of "specialists" and farmers at the same time. In many cases, the capacity of field workers in participatory research and extension should be strengthened (Brummett and Pouomogne, 2004). Extension does not need to be a government monopoly. In some countries, farmer field schools have developed and are supported by NGOs, as in Uganda; farmers interested in improving their skills pay and stay, and work day-to-day on demonstration farms for up to a month depending on what aspects of aquaculture they are interested in, for example, hatchery or growout production (Isyagi, 2009, p.30).

In addition to extension services, the development of aquaculture technology transfer centres may help in the creation of an effective and efficient network of knowledge exchange. Governments could play a significant role in the creation of these centres, as shown by Madagascar.

Madagascar: Technology transfer centre CDCC

The "Centre de Développement de la Culture de Crevettes", Centre for development of shrimp culture, functioned from 1996 until 2001 with funding and technical assistance of the government of Madagascar and Japan. The objective was to promote shrimp culture on a small-scale, through:
1. Developing small-scale family shrimp farming, in collaboration with small-scale fishermen
2. Researching the best possible shrimp farming techniques for small-scale farmers
3. Ensuring the technology transfer to the relevant stakeholders (Ranaivoson, 2009, p.23).

Another new concept is that of "Aqua-shops". A DFID-funded Research into Use project will be starting in Kenya by April 2010 to set up a franchise of 6 commercial aqua-shops in rural areas in western Kenya where a private individual or organization (franchisee) sets up and runs a shop/premises selling aquaculture supplies, equipment, feed, chemicals, pharmaceuticals, fertilizer, and provides information for either novice or established fish farmers. These aqua-shops will be set up in regional or district towns in western Kenya (for a link to the project wiki see: http://sites.google.com/site/aquashopswiki/home).

Use of new information media

In order not to depend only on expensive training and visits, extension, knowledge and information exchange should also look into the use of the media and new technologies. Mobile phones, internet, virtual networks (like SARNISSA), radio and newspapers can all play a role and are increasingly used in other sectors of agricultural development.
Uganda: New ways of information exchange

There are information services on a daily basis freely available to the public. Internet service providers have information that can be accessed on [www.cgiar.org/foodnet](http://www.cgiar.org/foodnet). Small-scale traders can also access market information on the cell phone providers (e.g. MTN and Celtel/Zain) at a cost. Most fish farmers as well as some implementers and policy makers, however, are unaware of this service (Jagwe et al., (2001) quoted in Isyagi et al., (2009), p.21).

Several relevant government departments, the producers themselves, and market sectors, are increasing their profiles and information sharing through initiating their own website sites and similarly becoming more active in participating in a range of networks.

DRC Fisheries Minister introducing on video the new national aquaculture strategy document to parliament

Increasingly websites and online video clips are being used by policy makers and politicians to disseminate further information about their policies, strategies, programmes etc on aquaculture development. One example is the DRC Fisheries Minister introducing on video the new national aquaculture strategy document. See: [http://www.dailymotion.com/video/xa89g9_le-senat-adopte-une-proposition-de](http://www.dailymotion.com/video/xa89g9_le-senat-adopte-une-proposition-de).

Another example in media is the [http://www.aps.sn/aps.php?page=articles&id_article=67353](http://www.aps.sn/aps.php?page=articles&id_article=67353), promoting Senegal as an "aquaculture country" and using video as well as news articles.

National media, such as newspapers, are also increasingly available online with search facilities allowing anyone with internet connection to look for aquaculture/fish farming articles for their country. Recent examples include online information on the new Kenyan government aquaculture policy/pond building programme in their national media. This public sharing of information also increasingly allows feedback and questioning, sometimes criticism, of the content or accuracy of the information given in the articles and media. Emails or letters may be written back to the newspaper editor and often get published, questioning the use and validity of certain statistics on aquaculture, the appropriate use of funds etc. Although still in its infancy, such an informal but very effective stakeholder consultation process, independent of government or project funding, could be set up in these ways and possibly allow for more objective responses and exchanges.

Left image: Accessing information: fish farmers and potential new entrants increasingly access the Internet to search for information, publications and contacts. SARNISSA Fish Farmers internet workshop. Internet Café Mwea, Kenya, June 2010

Right image: Philippines government funded E-extension website with publications, online advice and short distance learning courses (for example on seaweed cultivation). Part of the information and services are offered for free, for other there is a charge that farmers are willing to pay.

As internet-based information, however, is still limited in several areas in terms of reaching rural farmers and small local governments, or is not always reliable in terms of connection, use of virtual media should still be combined with hard-copy publications and materials, on-farm visits and face-to-face extension services.
Lack of sustainability and funding

As aquaculture research in sub-Saharan Africa has still mainly been oriented at scientific publications and graduate student research, prioritising the interest of politicians and donor organizations over those of local farmers, little actual impact has been achieved, resulting in lack of resources and sustainability (Brummett and Rana, 2010).

Cameroon and Zambia: Lack of funding

Various research programs have halted, because they were solely dependent on funding by foreign donors. The National Centre for Animal Husbandry, Veterinary and Halieutic Training in Foumban, cameroun, has temporarily stopped training students in 2009, after having waited for funding for two years (Tangou, 2009, p.30/31).

In Zambia, due to limited financial resources and manpower available, research on the production of fingerlings of Labeo altivelis and farming of the crayfish was halted by the country’s National Aquaculture Research and Development Centre. Progress on the implementation of such programmes could have enhanced commercialisation and benefits from aquaculture (Mudenda, 2009, p.32).

Generally, government funding for research is limited, in part because aquaculture research may not be considered a priority area for development and funding, or because politicians are not clear on its benefits. The only African country that funds aquaculture and fisheries at anything near the level required is South Africa, and that is because their fisheries sector actually produces fish and jobs. In addition, donor support for big development and research projects in the fisheries and aquaculture sector has decreased substantially over the past years. Increasing emphasis is placed on short-term impacts (in terms of improved incomes, more jobs and more fish in the market) and on proposals that define a new role and modus operandi for linking research to extension and farmers (Brummett and Rana, 2010, p. 4).

Universities and research institutions, however, could play their roles more actively in international exchange/internship and network development. Moi University in Kenya, for example, is known for its good standard and regional network; the university attracts students from neighbouring and other African countries, and participates in international (Swedish) student exchange programmes. Through such regional and international networks, funding opportunities from abroad can become accessible (Ngugi and Manyala, 2009, p.22). BUNDA College in Malawi has a similar role and status, as it trains students from Uganda, Zambia and Namibia. The SARNISSA case studies also clearly show that there is good scope for regional collaboration and networking. Such exchange offer many opportunities for learning (see the cases identified in this report) and could take into account the strong points of aquaculture development, research and policy making in the various countries and facilitate new forms of information and knowledge sharing, such as on-farm trails, study visits, farmer-to-farmer exchange, “aqua-shops” and platforms for dialogue and networking at local, national, regional and international levels.

Role of research in informing (improved) policy making

As outlined in the country studies and discussed in the SARNISSA e-conferences on Networking and constructive dialogue among researchers and policy makers in the field of aquaculture (28 September-12 October 2009), effective research can also contribute to improved policy making on aquaculture, provided that the following takes place:

1. Improved dialogue and networking between researchers, other non-governmental stakeholders and policy makers, as it improves the quality of the diagnosis of the actual situation and helps inform decision making on the courses of action needed. This is achieved through a better understanding of priority issues and the needs of different stakeholders involved, and a better linking of different sources of knowledge, information and expertise. Currently, the extent to which such dialogues are taking place varies both within countries but also between them, but is generally not happening at the level necessary for meaningful (ex)change. Networking is also a way for researchers to secure access to and discuss new information and learn from the achievements of others. In this way, networking does assist in research priority setting.

2. Evidence based information to inform policy making and action planning. Research outputs should try to address the concerns of policy makers. Policy makers are concerned about whether research carried out addresses local and national interests. Researchers therefore need to ensure that research results both meet the identified needs of different types of aquaculture farmers, and contribute to the country’s overall policy goals (such as economic development, which may, for example, call for more market-oriented forms of aquaculture). Policy makers will also be more interested in aquaculture if they can be shown real examples of aquaculture practices in the country that are profitable and financially viable. Information should clearly demonstrate what aquaculture can deliver, what problems are faced by various stakeholder groups and how these may be solved. Information should be concise, objective, accurate, traceable and timely.
One of the biggest needs here is the establishment of baseline studies and a thorough evaluation of the state of the art of aquaculture sector performance for various production systems, i.e., providing clear, concise, non-exaggerated statistics and information about aquaculture in each country. On the basis of such studies, policy frameworks can be developed and action plans, including R&D programmes, conceptualized, whereby the participation of various stakeholders should ensure that policies and programmes are geared towards the needs of various types of producers and other actors involved in the production and marketing chain. For example, and where not in place, guidelines should be developed for marketing and quality assurance for local consumption and export; other needs for R&D include the development of adapted, integrated production systems and of adapted and acceptable technologies for fish processing.

Research can also play a role in documenting, compiling and disseminating comprehensive guides to existing rules and legislation. Subjects such as land-access-rights, access to communal water, environmental and biodiversity regulation and necessary documentation to start an aquaculture venture are of specific interest to (potential) farmers. Similarly, and following the example of ‘The Uganda Commercial Fish Farmers Inputs and Services Guide’, a simple guide could be compiled with the relevant rules, legislation and guidelines for novice aquaculture entrepreneurs.

3. Improved forms of how (research) data and information are presented to policy makers. Policy makers are busy and often do not have time to read the outputs prepared by researchers. In addition, research outputs are often presented in a format that is not easy to understand by non-specialists. Research findings are mainly published in scientific or academic journals with extremely limited circulation and access, as this is important to the individual and institutional careers of the researchers. These journals are, however, not easily accessible to end users or policy makers. Researchers should be better trained/supported as well as use their own initiative and imagination to summarize and publish their findings in user friendly formats for policy makers and a wider public.

4. Networking and dialogue at different levels. At country level, national focal points could be identified to animate and facilitate contact among aquaculture stakeholders. Terms of Reference for the focal points should be developed, and might include the organization of regular meetings bringing together aquaculture stakeholders. National aquaculture observatories could be established containing databases/information on several aspects of aquaculture (biophysical data, research outputs, human resources, policies and strategic plans) and put up on-line and/or be available at particular locations for anyone to use to form a reliable reference point for any intervention in aquaculture development. This would require participation of all stakeholders, adequate funding and strong support by policy makers.

5. Continued functioning of existing exchange forums and networks, such as SARNISSA and ANAF (African Network for Aquaculture and Fisheries). However, apart from facilitating information exchange, these networks should also look at mechanisms for funding and implementing the plans they develop. Network members should look within their institutional programmes and budgets to determine how they can implement common actions using their own funding, rather than external funding only.

6. New strategies for improving networking and dialogue. These strategies may include:
   - Exchange visits for policy makers and fish farmers to different countries, dissemination of printed material, and use of radio and television. Information should be targeted at and packaged for specific stakeholders. This, however, requires resources, possibly supported by government and sub-regional organizations
   - “Pairing of researchers and policy makers” is an innovative strategy to improve communication and understanding between the two groups. Policy makers would visit researchers and their projects or fish farmers and their farms, followed by times when researchers/fish farmers would pair up with policy makers.
   - Organization of "Write-shops" with a group of selected researchers. Researchers bring in the findings they wish to present and are supported by professional communication specialists to put this information into formats that policy makers can understand. Draft formats are shared with policy makers to get their feedback, upon which researchers make improvements. Professional designers may then help to put these in a user-friendly format. At the end of the workshop, publication/information materials have been developed.
   - Organization of visits for groups of policy makers (or groups of mixed stakeholders; entrepreneurs, policy makers, donors, researchers, etc.) to successful commercial and smaller-scale farms within the country or region, or to other parts of the World, especially Asia. Multimedia/video materials may also be prepared on successful examples of aquaculture farms available within each country and recorded during study tours for distribution.

Organization of an e-workshop between researchers and other stakeholders.

**Role of research, training institutes and other actors**

There are many opportunities for research, educational and training institutions to play a more important role in the development of the aquaculture sector, especially if they:

- focus more on demand-driven and participatory research that is responsive to the needs of farmers (and prioritize on-farm results over publication records),
- meet skill gaps by training their staff accordingly to the type of jobs they prepare their aquaculture graduates to go into,
- better monitor uptake and effectiveness of their training and research programmes,
- help provide baseline and evidence-based information to policy makers.

Given the fact that however many aquaculture research departments are limited in staffing and funding, on-farm technical training as provided by various commercial farms can play an important role in the dissemination of skills and knowledge to farmers. In addition, the on-farm trials that are linked to such establishments are a solution to the limited funding for applied research that other institutions have to cope with. By demonstration, such commercial farms also play a role in showing the financial viability (or not), of specific production systems to other existing fish farmers or potential new entrants.

Aquaculture producer organizations, in their turn, have a role to play in serving as a forum for information sharing among their members and linking up with research organizations to participate in defining, implementing and monitoring research and achieving updated information on relevant technology practices.

Governments in their turn should invest in training and research, especially in those areas that are unlikely to be provided by the private sector. In collaboration with research institutes they should also collect and publish reliable and up-to-date statistics on the performance of different aquaculture systems and of government programmes and policies.
6. National policy development and implementation

Sustainable aquaculture development requires establishing an enabling policy environment, based on clear visions, objectives and target group definitions, resulting in adequate operational national aquaculture strategies as well as appropriate legislative frameworks, rules and regulations and monitoring procedures. This, in turn, requires clear institutional frameworks, strengthening of relevant national institutions and government departments and making funding available with clear budgets for policy implementation. Policy coherence between various sectors relating to aquaculture development, including the environment, agriculture and food production, and trade sectors should be improved. There should also be calls for multi-stakeholder policy formulation, including involvement of end-users, private sector and other stakeholders. This chapter analyses some of the aquaculture strategy plans described in the in-country reviews, highlights their weaknesses and strengths as well as makes recommendations for improvement.

Aquaculture strategy plans

Resulting from a decline in capture fisheries, increased food prices and increased demand for fish, currently, many countries have developed (or are developing) specific aquaculture strategy documents or plans, independently of their agriculture or fisheries sectors. Such sector-specific plans help to create awareness of the importance of the aquaculture sector and can eventually lead to institutional changes, providing aquaculture its own or a better institutional home. As Ngugi and Manyala (2009) state: “One of the main weaknesses of this aquaculture industry in Kenya has been lack of policies on aquaculture coupled with constraints in technology transfers, standards and certification process for aquaculture and aquaculture production. In the past, all food policies and food related policies barely mentioned fisheries or aquaculture as a means of food security, nutrition, employment and income but it forms a substantial source of nutrition among the rural farmers living in high potential areas”. They continue to say that “During the preparation of the Poverty Reduction Strategy Paper for the Agriculture sector, aquaculture was recognized as one of the core activities that can contribute to poverty alleviation in rural Kenya”. In the case of Kenya, this led to the creation of a Ministry of Fisheries Development in 2008, evolving from the former Ministry of Livestock and Fisheries Development. This new Ministry has the mandate to commercialize fish farming through increased investments, capacity building, and field-based applied research with contact farmers.

In many of the other countries reviewed the structures of the ministries responsible for aquaculture and the respective departments have also changed in the past ten years, in some cases, repeatedly. Not always have these changes led to a clearer and more transparent structure, nor have they necessarily improved aquaculture policy and project development. Restructuring government infrastructures is costly and should be done carefully. There is no clear evidence that a separate Ministry for Aquaculture (as in Ghana and Kenya) has been more successful or effective than placing aquaculture under the Ministry of Agriculture or Livestock (Ivory Coast, Cameroon, Congo, Madagascar, Malawi, South Africa, Uganda and Zambia). Evidence shows that the effective performance, impact and related outputs towards aquaculture development of such government infrastructures seem to have more to do with the presence of sufficiently qualified staff, availability of a defined budget, and thus resources for implementation, and a clear vision, strategies and policy instruments, differentiated for different aquaculture species and systems. Especially for countries with limited funding and staff, prioritization of development of specific aquaculture systems and specific, high-potential areas will help to respond more efficiently to specific policy goals (being oriented at food security, economic development or foreign exchange earnings, for example).

Lack of clear vision, objectives and strategies

When trying to analyse and understand a country’s strategic vision behind their aquaculture policy, it is generally hard to find clearly formulated objectives and strategies. Before a national aquaculture policy can be conceptualized, stakeholders in the sector should, together with policy makers, prioritize the roles or explain how aquaculture contributes to national development goals, such as; poverty relief, job and income generation, accessibility of cheap protein for the poor, improved ability to respond to external shocks, such as drought, conflict, or sudden price increases through less exposure and increased adaptive capacity (Beveridge et al., 2010, p.4), development of rural areas, earning foreign exchange through export or saving on foreign exchange through import substitution. If a policy framework lacks clarity and direction, interventions defined within the framework are likely to fail. In addition, the groups/beneficiaries targeted by the policy should be well chosen and clearly defined.
Aquaculture planning for small-scale community type aquaculture. Objectives, activities and target beneficiaries have to be clearly stated (West Kenya 2009). Do aquaculture planners, government fisheries extension staff and overseas donor driven NGOs know whether small ponds like this are economically viable for low income rural people? If they don’t know then they shouldn’t be promoting it.

In defining an aquaculture strategy and policy, various questions should be answered. Is the major aim to promote subsistence farming or the development of small, medium or large-scale commercial enterprises, or both? Which production systems and species could be best promoted towards these goals and in which areas of the country? Who should benefit or be supported and what are their needs? What support strategies and policy instruments that should be developed by the government are needed to support different types of aquaculture production systems? What tasks should be taken on by other sectors/stakeholders that can carry these out far more effectively than the government can? Who should do what and with what resources? It is in this respect for example that the Kenyan aquaculture policy is cited as being “far too generic”.

Kenya: "Far too generic policy"

The Kenyan policy regarding aquaculture, does build on a clear vision and states as their overall objective for developing a fishery industry: “to create an enabling environment for a vibrant industry based on sustainable resource exploitation, providing optimal and sustainable benefits, alleviating poverty and creating wealth, as well as taking into account gender equity”. It however does not differentiate intervention strategies and policy instruments for different types of aquaculture that could be developed in order to fulfill these objectives (Ngugi and Manyala, 2009 pp.14,15).

This is also true for other national aquaculture strategy plans (for example, the Nigeria national strategy 2008; the 2008 Uganda national aquaculture development strategy and the 2009 Cameroon strategy document for sustainable development of the aquaculture sector) that, although they list a variety of policy objectives (varying from improving livelihood conditions of fish farming communities to reducing import of fish), a variety of aquaculture systems to be developed (including, for example, integrated fish farming, ornamental fish farming, shrimp farming, etc.) and a large number of strategies to be put in place, there is no clear link between various policy goals, the specific types of aquaculture and related specific support measures to be developed (though the Ugandan strategy in one place specifies different government roles in research for either commercial or non-commercial aquaculture; 2008 Uganda national aquaculture development strategy, page 10). In addition, these strategies are very vague on, or do not mention at all, set targets and clear impact indicators, do not prioritize the strategies mentioned, and do not define clear institutional implementing frameworks and financing mechanisms. This may and does result in long wish-lists that cannot all be realistically achieved, for example:

- “governments should promote large-scale investment in fish-feed production” (but how, how to fund, whom in government? Should governments run their fish feed mills (as in Namibia) or encourage the private sector as in
Uganda and Kenya?

- “fish producers should supply feed at a fair price” (is this realistic given the fact that any entrepreneur wants to make as much profit as possible?)
- “credit should be provided at preferential interest rates” (experiences in agriculture have shown that this is generally not sustainable and that alternative forms of financing such as guarantee funding, value-chain financing, group savings and credit schemes should be explored).

The three mentioned strategy plans are also 80-90% similar in the proposed outlined strategies, which questions the extent to which they really take into account country-specific lessons learned in the past, specific country contexts and institutional arrangements and specific national policy goals.

Some strategies (such as that of Nigeria) start defining high or low priority zones for each type of aquaculture based on bio-physical or socio-economic suitability or potential. Concentration of aquaculture development in areas of high potential will facilitate exchange between farmers, and will encourage the emergence of professional organizations, reducing the constraints met by farmers (Desprez, 2009, p.19). However, and again, a clear(er) identification of which systems to promote and in which of these potentials areas is lacking.

This is not to say that these strategy documents do not make a good start by outlining roles to be played by various stakeholders and could not provide a good basis for further development of aquaculture plans that are more detailed and precise than strategies. This will require, however, that the plans to be developed do respond to the questions; why (overall objectives), for whom, how, by whom, where, when and with what resources.

**Policies needed for specific aquaculture systems**

To enhance implementation, guidelines or policies governing the operations of a specific aquaculture production system or industry would be useful. In Malawi, for example, ornamental fish farming for export could generate more benefits if this type of aquaculture business was recognized in government policy and there was an appropriate regulatory framework to encourage investment and ensure quality. Other examples include the gradually increasing commercial cage culture sector in Ghana, Zimbabwe, Uganda, etc., where government regulatory environmental legislature, water/land ownership/licensing is still in its infancy, thereby uncertain and discouraging for potential new entrants.

The policy of Ghana includes elements that seek to promote and encourage commercial aquaculture enterprises, for example, imported aquaculture inputs are tax exempt (nets, feeds and general equipment), importation of farmed fish products are not officially permitted in Ghana and some “in-kind credit” in the form of fingerlings and fish feed has been made available to fish farmers under a nationwide scheme. However, and at the same time, a countrywide, established research and development agenda for commercial aquaculture is missing.

Uganda’s Plan for Modernization of Agriculture has a key overall objective to improve livelihoods through market oriented agriculture, including aquaculture. As a result, the aquaculture policy of Uganda states increased production as a main objective. This could be achieved by promoting mainly large-scale commercial farming. However, in doing so, the policy would benefit only a handful of, mainly richer, farmers, ignoring the large number of small-scale farmers, who are in majority. However, further objectives such as generation of employment opportunities for small-scale farmers and increased income and sustainability, with respect to rational use of natural resources, and technical and economic viability, or extensive pond systems, most of which are in line with farmers’ objectives, are, however, not found in the policy (Isyagi et al., 2009). A review and change in existing policy may therefore be needed.

Mariculture development and cage culture in Africa requires specific objectives and activities within government aquaculture development strategy planning (Mayotte 2009).
Strategy plans and policies should be regularly evaluated and adapted where necessary. Aquaculture strategy plans should be considered as “rolling agendas”, ensuring monitoring and learning from implementation to assess the need for changes in strategy. As is frequently observed in the country studies, however, adequate surveys and in-depth studies to provide a solid basis for policy and strategy formulation are often lacking. Alternatively, there are long time lapses between policy formulation, policy adoption and the formulation of a concerted action plan. In the case of Malawi, four years passed between policy formulation and development of an action plan, with the result that the strategies formulated no longer applied to the rapidly changing circumstances (the market price of shrimps, for instance, collapsed a few years ago, making a review necessary of the relevance of outlined strategies for support to the sector).

**Need for a clear and enabling legislative framework**
Several of the in-country studies report unclear or complicated legislation, specifically related to land access rights and environmental legislation. In several cases, only farmers with access to their own sources of water can farm fish, as the rights to use communal and public water are often unclear or limited. Unclear water and land rights can lead to community conflict, as has been the case in Kenya, South Africa and Uganda. Governments should establish clear and secure user rights to land and water for aquaculture. This would also encourage investment in the sector.

Environmental legislation is becoming increasingly important. Shipton et al. (2009) note that the aquaculture sector in South Africa is of the opinion that compliance with environmental legislation is the single most significant constraint to its development. Industry representatives frequently express desperation with policy makers regarding the increase in requirements posed by environmental legislation, especially the onerous Environmental Impact Assessment (EIA) procedures. Even large and medium sized companies with outstanding human resources and good corporate governance find it difficult, and very costly, to comply with such stringent environmental legislation, and for many small and medium-sized enterprises, it is simply too big a burden. In addition to national environmental legislation, international rules and legislation apply when commercial scale production and export takes place. The growth and export of the South African shellfish production (mussels and oysters) industry is currently constrained because South Africa’s “shellfish water quality monitoring programme” is not yet accredited by the European Union.

Governments can play a role in simplifying environmental legislation; though also have the responsibility to regulate certain types of aquaculture in environmentally sensitive areas. For example, conversion of mangroves and sea grass beds for aquaculture use should be avoided as they provide a wide range of ecological services, including the sequestration of carbon (Beveridge et al., 2010). Also, the use of alien and genetically modified aquatic organisms should be carefully controlled.

There may also be conflict in legislation as several ministries are often involved in aquaculture-related laws and regulation, for example, the Ministry of Agriculture, the Ministry of Public Health and the Ministry of Environmental Affairs. Lack of policy coherence is seen by Beveridge et al. (2010) as one of the two main constraints in realizing the potential of aquaculture. Likewise, in 2009, the ACP fishery ministers called upon the ACP states to strengthen policy coherence among various sectoral policies (ACP, 2009, p.8). The case of Uganda, for example, brings to light the lack of coordination among the ministries or departments for finance and trade and industry.

**Uganda: Conflicting policies**

Many policies that directly or indirectly affect the process and the outcomes of planning and policy formulation (regarding aquaculture) are scattered in different government departments and are made independent of each other. The result is individualistic departmental approaches that are pursued by each specific sector with little if any consideration of what the other departments are doing. This has had multiple effects; in some instances, implications of different policies have been contradictory where in others there has been duplication of work, which is a misuse of the country’s already meagre resources (Isyagi, 2009, p56).

Legislation and policies are furthermore not differentiated for different scales and types of aquaculture. In Malawi, for example, the National Fisheries and Aquaculture Policy does not have a strategy on how the niche sector for ornamental fish farming might be promoted and protected. Many stakeholders describe this aquaculture ‘market niche’ as a gold mine. It is important to recognize different types of aquaculture business so that appropriate legislative and regulatory frameworks are formulated to encourage investment and ensure quality.
Need for technical guidelines and standards
Next to (environmental) legislation, there is a need for further technical guidelines and standards, such as sanitation measures, quality standards, standards to encourage niche market production, such as ornamental fish and zoning of fish waters. The Malawi Gold Standard, focusing on small-scale fish farming, is a good example.

Malawi Gold Standard

The Malawi Gold Standard (MGS) describes a standard production system that will assist small-scale farmers in realizing maximum returns to investment. The MGS is used as a guide by all stakeholders that promotes aquaculture in the country (Mwale, 2009, p.6).

Stakeholder participation in policy making
Until recently aquaculture policies in SSA were mainly oriented at food security and poverty alleviation. At present, businesses and related value chain improvement and marketing strategies seem to get more attention in policy formulation. This raises the issue of the need to involve specific stakeholders (such as aquaculture smallholder producers and their organizations, entrepreneurs, and financing institutions) in the various phases of policy formulation and implementation. In many cases, policy frameworks have not been developed in sufficient collaboration with the stakeholders involved, often resulting in failures in policy implementation.

Zambia: Top-down policy making

The Zambian governance and planning history can be briefly summarised as characterised by “a stop-start” administrative system. This is not necessarily as a result of lack of development policies, but largely as a result of weak implementation of policies. It very easy to introduce policies in Zambia but problems often arise during implementation (World Bank 2004). This suggests that methods used to introduce policies need critical review - in most cases a top down approach was employed where stakeholders were not consulted in the formulation of development policies and programmes (Mudenda, 2009, p.42).

The Ugandan policy document highly emphasizes the need for the private sector to invest in the sector. Without denying the important role the private sector can play, the policy fails to describe why and how this should take place, nor outlines consequences and alternative strategies in case the expected investments do not materialize.

The government could collaborate with other stakeholders to form a conglomerate (like in Madagascar) or multi-stakeholder platform, so that policy formulation and implementation, research, development and knowledge exchange become the responsibility of the whole sector. The government could take on the task to coordinate the various inputs and efforts.

Coordination mechanisms for aquaculture sector development in Madagascar

In Madagascar, a new aquaculture strategy plan was formulated during 2005, with specific roles assigned to government, the private sector and the fish producers associations. The aim of the plan is to create employment, improve profit for the producers and to boost the gross income within fish producing sector. By 2007 more than 3000 tonnes of fish, mainly carps and some tilapia were produced by private entrepreneurs. Madagascar has gained itself a place in the international shrimp market and has been able to deliver good quality products. The designation “Shrimps produced in Madagascar” has for many years now been a guarantee for good quality. Good collaboration between private sector and government in the shrimp sector has been a major factor behind this success. More than 300 technicians have been trained and employed in government services in functions that are supportive to development of the sector. The Institute for Shrimp Production Development provides technical training for technicians and for shrimp producers.

The GAPCM, Groupement des Aquaculteurs et de Pêcheurs de Crevettes de Madagascar, was formed at the request of the Fisheries Department and acted as unique and valued spokesman of the sector. As part of the Master plan, the government handed over all the existing fishery stations to producer associations. This privatisation process has resulted in these stations running effectively and still playing a major and relevant role in the development of the aquaculture sector (Ranaivoson, 2009, p.5).

South Africa is an example of a significant level of stakeholder participation in policy making. During the development of the country's mariculture policy, stakeholders such as researchers, industry associations, and individual farmers were provided an opportunity to comment and make input into the process. In 2005 a new strategy plan was formulated, with
roles assigned for the government, the private sector and the fish producers’ associations. The aim of the plan is to bring about employment creation, improve profit for the producers and to boost the gross income within the fish producing sector. It would be interesting to monitor if the policy, formulated in this way, has lead to (more) significant successes than would have otherwise been the case.

The ten SARNISSA in-country policy studies do show that in cases where all stakeholders have participated in policy formulation and action planning, policies are more widely accepted, well formulated and conceptualized. Apart from the poor representation of end users in the policy formulation process, poor dissemination of the policy documents, rules and regulations and technical guidelines is another constraint identified. The availability of relevant policy documents leaves a lot to be desired. Government documents such as development plans and session papers are difficult to get hold of and thus are not read or even known to many stakeholders. This results amongst others in uncertainties about statutory requirements such as Environmental Impact Assessment (EIA) and about which environmental standards to use and enforce. Both the dissemination of the document should be improved, as well as their accessibility (in terms of language, for example) enhanced.

Poor coordination in and lack of funding for implementation

Poor coordination in implementation and lack of funding to implement the identified activities are also mentioned as contributing towards (nearly all) policies being less effective than anticipated (as also mentioned in Beveridge et al. (2010)). In the case of Malawi, a Presidential Initiative on Aquaculture Development (PIAD) was launched in February 2006, a project implemented by the Government. Because accorded a high priority by government, Malawi has the framework, instruments and institutions that provide an opportunity for developing the sector further. For example, the overall objective of the NASP (National Aquaculture Strategy Plan) is to facilitate the necessary institutional, legal and administrative changes in the sector, and to increase the capacity of stakeholders for:

- the improvement of livelihoods of rural smallholder fish farmers
- establishing a successful commercial aquaculture sector
- providing the quality aquaculture services at national and local level.

The NASP document addresses key constraints on aquaculture that currently limit its growth and productivity in Malawi.

However, a SARNISSA case study on the Malawi NASP also states: “The results show that the institutional structures that were proposed to implement and monitor all the NASP strategies and activities have not been formed. This has led to lack of knowledge of the document by some stakeholders. Poor coordination and networking among the stakeholders has also led to the failure of the strategic plan” (Banda et al, 2009).

The case study concludes that there is an urgent need for the formulation of a separate institutional structure to look into aquaculture development in Malawi with the help of the Department of Fisheries (DoF) and all the stakeholders so as to help review and process the NASP action plans if progress is to be achieved. This finding is supported by Mwale (2009) who states that “The sector is not properly coordinated. While it is appreciated that there are many players in the aquaculture sector in Malawi, i.e. government, NGOs, farmers, farmer organizations, private sector, financial institutions and market players, there is a limited opportunity for these stakeholders to share their expertise and experiences because such a forum does not exist in the country”.

In recent years in South Africa, aquaculture has begun to feature more prominently on the government’s policy agenda, with an unprecedented number of initiatives developed by national and provincial departments to promote the development of the sector. Unfortunately, the various policy and support measures have been implemented in isolation, and the goal of a coordinated national aquaculture policy and strategy has so far not been reached.

As mentioned before, aquaculture is subject to different sets of rules and laws originating in different ministries (e.g. the Ministry of Agriculture, the Ministry of Health, Ministry of Finance, and the Ministry of Environmental Management). Coordination and information exchange between the different ministries and departments is often lacking, leading to possible conflicting rules and regulations and poorly coordinated implementation of policies.

Putting aquaculture on the agenda and according it high priority, not only through (coordinated) policy formulation, but also by providing sufficient staff and funds, is crucial to the sector’s development. In South Africa most national government departments now have a departmental aquaculture policy in terms of their legislated mandates, and dedicated aquaculture staff have been appointed within the Department of Agriculture, Forestry and Fisheries (DAFF). If activities cannot be implemented due to lack of staff or funds, the government will act solely as a control agent rather than playing a facilitating role.
Ghana: Good policy but limited implementation

Due to staff and financial constraints many aquaculture programmes and projects could not be fully implemented. For these reasons a research and extension linkage committee that was set up in 1998 by Ministry of Food and Agriculture as part of a national agriculture research programme, stopped functioning in 2004 (Abban et al, 2009, p.62).

Funding is needed for policy implementation and for the establishment and functioning of a multi-stakeholder conglomerate or platform involving all stakeholders in implementing base-line studies (see below), policy formulation and action planning, at least during the start-up phase. Although external funding can be accessed and private sector investment be promoted, financial support by government is needed for those sectors/activities that will not be funded by the private sector (e.g. training to subsistence farmers), for creating a “conducive” environment for other investors (for example, improving infrastructure, supporting start-up costs) and for research and extension (though co-funding by the private sector and by farmers themselves should be explored). As mentioned earlier, funding should be based on principles of sustainability and, for example, large programmes that construct ponds and give out fingerlings for free (see recent experiences in Kenya and Uganda, see also http://www.newvision.co.ug/D/8/220/727009) should be avoided, as past experiences have repeatedly shown that the majority of those ponds will be abandoned after project support ends.

Lack of clear, realistic outputs and impact indicators

To monitor the effectiveness of policies and programmes, clear outputs and expected impacts (for example, realistic number of farms to be set up; expected production outputs; envisaged contribution to income generation and employment creation) need to be formulated. Very few of the studied policies, however, do set such targets. Monitoring and auditing activities are therefore not possible. In addition, baseline studies, producing accurate and realistic statistics, are seldom used as a basis for strategy and policy formulation, thus also inhibiting the possibility to monitor changes.

The Ghana National Fisheries and Aquaculture Policy (2008): No clear output objectives

The policy objectives for aquaculture, referred to in the policy document as “Operational Objectives” were well targeted to the development of elements and issues of aquaculture, recognised as major constraints to various scales of the aquaculture industry. Issues such as fish seed, feed, capital, human resources, partnerships, research, education and training and extension were identified, and policies were provided for their development. Objectives of the policy however have only been categorically and comprehensively stated. Identification of operational objectives with reference to the different target groups would have given clear measurable objectives and monitoring possibilities (Abban, 2009, p. 40).

Before being able to plan for the development of aquaculture in a given country, it is important to understand the current presence and past history of problems and potential of the various types of aquaculture whilst also being aware and learning from policy and aquaculture strategy planning in other countries. One of the first tasks in any policy formulation and planning process is therefore to establish a base-line or situation analysis on aquaculture. From this a national policy can be developed, which culminates in concrete actions in the fields of extension and knowledge exchange, research and development in technological, socio-economical, environmental and legal subject areas, training and education, etc. These concrete actions could be executed and monitored by the various members of a multi-stakeholder platform or conglomerate, in which farmers also participate, either through farmers associations or individually.

Factors for successful policies

Several factors contribute towards (nearly all) policies being less effective than anticipated. The most frequently mentioned reasons are: lack of clear objectives and strategies with related output indicators; poor representation of end users in the policy formulation process and poor dissemination of the policy itself; poor coordination in implementation and lack of qualified staff and funding to implement the identified activities.

Furthermore, strategy plans lack clarity on the contribution of the sector to national development goals, and, as a result, is often unclear which type and scale of aquaculture enterprises the policy seeks to stimulate and how it can best do so. Use of appropriate policy instruments such as (environmental) legislation, training, financial support or economic incentives, or others should be defined to enhance specific aquaculture production systems in specific high potential areas of the country. Measurable operational objectives, impact indicators and a monitoring framework are needed for monitoring, evaluation and learning, thus allowing for timely changes in policy orientation and implementation.

Coordination between various ministries and departments in formulating an enabling policy and legislative framework, as
well as in implementation, should be enhanced. Research organizations, farmer organizations and private sector all have a role to play in policy formulation and implementation. Well coordinated stakeholder participation has been shown to give better results.

In conclusion, any policy, plan or programme is likely to be more successful if:

- it is based on an adequate analysis of actual potentials and problems,
- it is based on a clear view of the desired role and functioning of aquaculture (or various types of aquaculture types, avoiding the trap of promoting just one type, for example, “monoculture based on quality seed and extruded fish pellets”...),
- it has selected policy measures/instruments/strategies (i.e., legal instruments, training, research, extension, financial support, etc.) that are effective in producing the expected changes with the means available,
- it has an adequate institutional framework (outlining roles of different stakeholders) and human resources for the implementation and monitoring of these measures and intervention strategies, which are clearly related and intermeshed with a detailed budget for each component within the strategy (the budget being accurate and relating to the funds that are guaranteed and actually available),
- it has sufficient legitimacy and public support (which often requires sufficient involvement of representatives of the people affected by the policy/plan/programme in its design and implementation and by effective communication to all others),
- it understands and clearly defines the roles and associated activities for developing aquaculture for not just the government sector but also other key sectors, such as the private sector, farmer organizations, etc.
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