TRIGGERS AND DRIVERS FOR ESTABLISHING

A PROFITABLE AQUACULTURE SUB-SECTOR

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REGIONAL OFFCE FOR AFRICA
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FOREWORD

Since 1998 the FAO Regional Office for Africa has actively supported aquaculture in the Africa Region. During this period, the Office has witnessed major changes in both the perceptions and practice of aquaculture. Whilst aquaculture at the end of the 1990s was nearly a negligible activity for much of the Africa Region, today the picture has changed significantly. There are more than a dozen countries that are now producing more than 1,000 metric tons annually from their aquaculture operations. Among these countries, those at the forefront have seen up to 20% of their domestic fish supply now coming from fish farming. Moreover, as fish prices continue to rise and supply fails to keep up with fast-growing populations, the future for increased investment in aquaculture seems bright.

However, we do not want our enthusiasm to overflow. We need to be realistic. We need to set achievable targets for the aquaculture programmes in African countries; identifying the triggers that will help us attain these targets. We need to guard against over expectations. Aquaculture is not a cure-all. And, we have seen what happens when the over expectations of the 1970s, when unfulfilled, ultimately led to the neglect and fall from favuor of aquaculture in the 1990s.

Whilst we need to guard against unattainable results, we do not need to lose our enthusiasm -- we need to channel it. Globally aquaculture now puts as much fish on people's plates as does capture fisheries. There is no reason that this cannot and should not be the case in the Africa Region.

The aim of this document is to illuminate the pathway whereby we can better understand the aquaculture sub-sector, its needs and its opportunities.

In the Africa Region we have many comparative advantages for accelerating aquaculture development. We need to optimize these and move quickly to contribute much more to the global harvest, thereby improving food security and promoting economic development in our Member Countries.

Maria Helena Semedo
Assistant Director General
Regional Representative for the Africa Region

ACKNOWLEDGEMENTS

This document is founded on enthusiasm and diligence demonstrated on a daily basis by African fish farmers and others engaged in the aquaculture sub-sector. Without this unflagging commitment, it is highly likely that interest in aquaculture would have long evaporated.

It is also important to highlight the crucial thrust that has been given to the sub-sector's development by those in the public and private sectors who have persisted through difficult years and are now seeing the opportunities on the horizon; promoting aquaculture and engendering much-needed political good will.

It is equally important to acknowledge the inputs generously provided by colleagues around the Region who have helped make this a work based on practical experiences encountered on the farm.

Finally, the help of Mr Justin Chisenga and other colleagues from the FAO Regional Office for Africa in the editing and publishing of this document is most appreciated.

EXECUTIVE SUMMARY

Aquaculture is an investment option. However, as with all solid investments, this option should only be transformed into action if, through comprehensive market and business planning, it proves to be profitable. Profitable aquaculture enterprises, aqua-businesses, can assume any scale of operations, from micro to industrial. But, at any size, it must be market-driven. For smaller operations, this implies the need for firms to band together to achieve an economic critical mass; forming clusters, pulling-down services and attracting better markets. A market and business orientation embodies the new approaches to aquaculture as an investment that can make positive impact on the developmental objectives of African Governments.

Aqua-businesses can utilize any of numerous aquacultural systems. However, the major systems as described are those raising tilapia or catfish in ponds, cages or static water tanks. These systems have an established track record in the Africa Region; using effectively local resources and providing products that are appreciated by local markets.

Realistic expectations for these systems are necessary. Whilst each general system represents a variety of options in terms of technology and level of investment, typical ***mean yields*** can be ascribed to these systems: ponds -- 2.5-4.0 MT/ha; tanks -- 15-20 kg/m^2; and, cages -- 25-100 kg/m^3. It is estimated that, region-wide, ponds numerically represent ≈ 70% of the enterprises, contributing about 20% of total production. Cages, the newest but fastest growing systems, numerically are less than 10% of all aquaculture operations but provide at least 50% of total production. Tanks fill in the balance, occupying about 20% of the sub-sector with harvests that add slightly less than 20% to the total market basket.

Establishing national programmes with viable aquaculture systems requires a variety of resources and inputs including, land and water, social [including human] and economic, environmental, legal and regulatory. Whilst all are very important, the input resources of high quality and affordable seed, feed, capital and information are often acknowledged as among the most formidable issues to address. When added to these the need for suitable markets, these "Big 5" constraints affect aquaculture development across the Region.

Approaches focusing on aquaculture as a business are not, however, to the exclusion to other types of aquaculture that are practiced throughout the Region. Aquaculture undertaken in a non-business way is referred to as "non-commercial" and may be synonymous with subsistence. These often family-based activities can make important contributions to household food supply and on-farm resource use whilst reducing risk through diversification. However, they make only modest contributions to community welfare with minimum, at best, impact on national goals. Nonetheless, typically non-commercial actors account for 80-90% of the individuals engaged in one way or another in the sub-sector, albeit this group contributes on average less than 20% of the national harvest.

Although some have set great stead in the possibility that these non-commercial farmers will evolve or emerge into commercial operators, this is seen, at most, in 15 to 20% of the cases. Non-commercial operators are functioning with a completely different set of priorities and resources.

National programmes are, accordingly, composed of a wide spectrum of actors and systems. These are an indication of a variety of factors including the presence of facilitating natural, political and economic environments. It must be acknowledged that aquaculture cannot be practiced everywhere and it is highly possible that some countries will not have the prerequisites to engage in significant aquaculture production. For those countries that do possess these prerequisites, their national programmes can be defined as being "progressive" or "incipient"; the former producing annually 5,000 MT or more though aquaculture, the latter yet to achieve this threshold. Within this classification, the present document notes that feasible **targets** need to be set and suggests that these be that 30% and 10% of domestic fish supply come from aquaculture for progressive and incipient countries, respectively, over the next five years.

There are specific **triggers** to assist in achieving these targets:

1. ***A successful cluster*** of producers and service providers will stimulate replication; promoting investing and garnering political support.

2. Success is equated with ***profit***. If real financial profits can be achieved through farming aquatic products, the sub-sector will grow.

3. An accompanying trigger is ***products in the markets.*** As consumers see acknowledged farm raised products increasingly in the market, they will accept aquaculture as a major supplier. This will further build the market and reinforce political support.

The **drivers**, core programmatic elements, that activate these triggers are:

4. To make money you have to have money. Accordingly, access to ***credit*** may be seen as a prerequisite. To a large extent, this requires convincing lending institutions of all sizes that aquaculture is bankable.

5. For a cluster to succeed, the required inputs of ***quality and affordable feed and seed*** need to be available.

6. Supporting production and market triggers is an important ***information*** driver. This relates to information at all levels; strong and visible producer associations, mention of fish farming in mass media and telecommunications as well as robust links with sub-regional and regional networks.

7. Information per se will not complete the picture. It is necessary to deliver these information products to users. This requires effective ***outreach*** -- a necessary and challenging trigger. Outreach is the two-way flow pattern that builds capacity in beneficiaries but provides critical feedback for monitoring and evaluation.

8. Closely allied to the networking driver is its sister: ***functional producer organizations.*** Organizations of active producers bolster the political support for the sub-sector and increase the efficiency of production, especially for SME operators.

9. Cutting across these areas is the driver of functional and effective ***partnerships.*** These transform mediocre or even conflicted programmes into synergistic movements that can rapidly move the sub-sector forward by optimizing the returns on resources invested.

10. A final transversal galvanizing agent is ***developing the needed capacity.*** This does not imply wholesale training or a flourishing of tertiary academic programmes. This is developing skills to fill identified gaps in such areas are farm and hatchery management.

Developing these triggers and drivers will set a pathway for the way forward that will lead to the overarching goal of increased sustainable aquacultural production. In many ways, success is magnetic; it attracts more investors, many of whom will also be successful. The hard part is getting the first part right. This means minimizing the risks and maximizing the chances for success. One needs to start with the best sites and the least challenging technologies where the market is assured. On the edges there are many innovations and possibilities for new and appealing enterprises. Whilst one definitely does not want to stifle innovation, at the current early stages of development, using tried and true technologies at sites that have the best possible match of socio-economic and bio-physical criteria favouring the system in question is the best tactic. With pilot self-sustaining profitable clusters firmly in place, these can be used as the foundation for building a larger and more diverse national programme. As this programme grows, the economies of scale will change and more services will be attracted to support the producers.

KEY WORDS AND CONCEPTS

ANAF
The Aquaculture Network for Africa -- a dedicated panAfrican aquaculture network promoting multi-country action on new approaches to aquaculture development in the Africa Region [http://www.anafaquaculture.org].

AQUA-BUSINESS
Aquaculture as a business [i.e., an enterprise that has the potential to make financial profit].

AQUA-FEEDS
Complete or supplemental fish feeds; the former providing the full set of dietary requirements whilst the latter provides only a portion of these.

AQUA-PARK
A site designated specifically for aquaculture development and housing a number of aqua-businesses; facilitating support services, delivery of inputs and marketing of products.

AQUACULTURE ADVISORY GROUP
A formal stakeholder group, often led by the private sector, that advises Government agencies on the best policies and practices for the development of the country's aquaculture sub-sector.

AQUACULTURE PRODUCTS
The crops grown by aqua-businesses.

AQUACULTURE SEED
The material "planted" in aqua-businesses; in the case of fish, this generally applies to the fry, fingerlings or juveniles stocked in a production system.

AQUACULTURE STATION
Public sector [Government] infrastructure established to support a national aquaculture programme. Typical functions have been for the production of seed and/or food fish as well as feed fabrication and being a training or demonstration site.

AQUACULTURE SUB-SECTOR
The component of the fisheries sector devoted to aquaculture.

AQUACULTURE SYSTEM
The combination of structures, technologies and species used to produce a specific product [e.g., tilapia ponds, catfish tanks, etc.].

BIO-CONSERVATION
Protection of the biota.

BIOMASS
The aggregate weight of a population of organism or organisms in a system.

BIO-SAFETY
Safety of practices with regard to their impact on humans and the environment.

BIO-SECURITY
Protection against the spread of disease.

BIOTA
The plants and animals of a particular region.

BREEDING CENTER
An aquaculture station specifically established and managed to undertake stock improvement work.

BROOD STOCK
Parent stock. The organisms used for reproductive purposes by hatcheries.

BUSINESS
An activity undertaken in an attempt to make a profit.

BUSINESS PLAN
The plan for an aqua-business, including the marketing aspects, that indicates what level of operation is required for the enterprise to achieve a financial profit.

CBO
Community based organization.

CLUSTER
A group of aqua-businesses, with or without a formal structure, but functioning as an effective economic unit.

CODE OF CONDUCT FOR RESPONSIBLE FISHERIES (CCRF)
Fisheries (which includes the management, catching, processing, marketing of fish stocks) and aquaculture (the farming of fish) provide an important source of food, employment, income and recreation for people throughout the world. With this situation in mind, the Code of Conduct for Responsible Fisheries was adopted in 1995. The Code is voluntary and aimed at everyone working in, and involved with, fisheries and aquaculture. The Code of Conduct consists of a collection of principles, goals and elements for action. Governments, in cooperation with their industries and communities, have the responsibility to implement the Code.

COMMERCIAL AQUACULTURE
Aquaculture as a business [aqua-businesses] that makes a profit. This can be the micro, small, medium or large scale. A crucial element in this categorisation is the intent of the operator. Commercial operations are seen as profit-makers by their investors. The designation of "commercial" does not include any requirement in regard to scale, size, intensity, technology used or level of investment.

COMMUNAL AQUACULTURE
Refers to aquaculture practiced by a group. In communal aquaculture the management entity is this group and not an individual; collective farming with a group operating one or more aquaculture production units [e.g., cages, ponds, etc.]. Whilst communal operations may appear appealing, especially when using common property for the farming, they are rarely sustainable. One of the time-honored lessons learnt through the early decade of promotion of fish farming in Africa was that communal aquaculture seldom succeeds.

CSO
Community Service Organization

CULTURE-BASED FISHERIES
These systems are cropped using capture fisheries techniques but the populations are maintained by stocking hatchery-bred juveniles. The systems are broadly considered as being aquacultural. A typical example would be the stocking of dams [small water bodies] on an annual basis using hatchery reared seed; these waters then being harvested through capture fisheries using hook-and-line, traps, or other fishing technologies.

DATA & RECORD KEEPING
Recording, collating and storing data relating to the functioning of aquaculture endeavours. Inherent in the subject is maintaining data throughout all segments of the value chain.

DIRT BUDGET
The difference between cut and fill. In building an ideal fishpond the cut is equal to the fill. Excess cut requires disposal of this excess whilst having too much to fill requires potentially procuring extra soil from outside the pond site.

ECOSYSTEM APPROACH TO AQUACULTURE (EAA)
This label has recently taken hold to describe the need for holistic approaches to aquaculture development [the corollary being EAF -- the ecosystem approach to fisheries]. The concept underscores the need for development efforts to be broad-based: covering social, cultural, economic, financial, ecological and physical aspects as well as the core bio-technical concerns.

EIA
Environmental impact assessment.

FINFISH
Teleost fish. Generally categories to contrast culture organisms or aquacultural products; invertebrartes [crustaceans, mollusks, etc.], finfish or other vertebrates.

FLOW-THROUGH
Aquaculture systems where water is continuously flowing in and out.

FOOD CONVERSION (FCR)
The amount of feed that must be consumed to gain a given amount of weight [e.g., and FCR of 2 means that two kilograms of feed need to be consumed for the organism to gain one kilogram in weight.

GENETIC EXOTIC
Exotic species are those that are of foreign origin -- non native. From an aquacultural perspective, this has traditionally been a terminology used to identify non-indigenous organisms, taxonomically to the species level, that may be considered for culture, or are being cultured in geographic areas outside their home range. With new high-tech tools, this differentiation can now be intra-specific, looking at genetic variations in different populations of the same species. As most farm-raised organisms are the products of some sort of controlled breeding, their genetic composition is inevitably different from wild stocks, even if they are being raised in their home range. Hence, to some degree all cultured organisms are genetically exotics. The challenge to those crafting best practices is to decide when this level of differentness poses some risk and when it does not.

GENDER NEUTRAL
An activity that is not traditionally or culturally designated to one or other gender.

GIFTS & GIVEAWAYS
Free or subsidized goods and services. Some promoters of aquaculture have seen these as being a (needed) stimulus to aquaculture. Quite to the contrary, experience has shown that these are counter productive and a central lesson learnt is that gifts and giveaways should be studiously ***avoided.***

GMO
Genetically modified organism.

HARVEST CYCLE
The growing period for the crop.

HATCHERY
An aquaculture facility, public or private, whose function is seed multiplication [hatching].

HIGH POTENTIAL ZONE
A site that has an optimum mix of bio-physical and socio-economic attributes that make it very suitable for a given aquaculture system.

INDUSTRIAL AQUACULTURE
Large-scale aqua-business -- often with external/international funding and support.

INCIPIENT AQUACULTURE PROGRAMME
An aquaculture programme that is just starting and still not making significant contributions to the national economy. Considered in the current context as national programmes that produce less than 5,000 MT annually.

MARKET-DRIVEN
Processes that depend on the market; specifically, designing aquaculture systems based on market demand.

NATIONAL AQUACULTURE PLAN
The planning document for a national aquaculture programme that describes how, where and when the NAS will be implemented, how much will be produced versus how much the programme will cost and covering a specific period of time.

NATIONAL AQUACULTURE STRATEGY
The strategic guidelines for a national aquaculture programme defining the roles and responsibilities of different stakeholder groups.

NGO
Non-governmental organization

NON-COMMERCIAL AQUACULTURE:
Aquaculture activities that do not have the potential for, or are not managed to obtain a financial profit; often called subsistence or family fish husbandry.

NURSERY
An aquaculture facility that procures immature fish seed and raises it to another life stage. Nurseries may raise fry to fingerling or juvenile size. These are links in the seed supply chain.

ONE-STOP-SHOP
An administrative structure established by Governments to facilitate investment in the aquaculture sub-sector whereby all information and requirements for investing are found in easy-to-use form in one location.

OUTREACH
Extension and adult education.

PRIVATE SECTOR
The investment and business community as contrasted with the public sector [Government] and civil society.

PRODUCTION UNIT
The medium or component of a particular aquaculture system [e.g., pond, cage, tank, pen, etc.].

PROFITABILITY
The ability of an activity to make and sustain financial profits.

PROGRESSIVE AQUACULTURE PROGRAMME
An aquaculture programme that has evolved to the stage whereby aquaculture is making appreciable contributions to Government's aims. Considered in the current context as national programmes that produce 5,000 MT or more annually.

PUBLIC SECTOR
Government institutions and institutions fully dependent upon Government.

RECIRCULATION
Aquaculture systems that reuse [recirculate] the same water many times, using a variety of filtration and other mechanisms to maintain minimum water quality standards for the species being cultured.

RISK
Degree of exposure to unwanted results. The level of "danger" that a given action will generate undesirable secondary effects. The chance that a venture will fail. Risks affecting environmental systems have multiple dimensions including socio-cultural, bio-physical, economic and ecological.

SEA
Strategic environmental assessment.

SME/MSME
Small and medium enterprises as well as micro, small and medium enterprises.

SPADA
The Special Programme for Aquaculture Development in Africa [Annex III].

STATIC
Not moving; referring to aquaculture systems that raise organisms in a volume of water that is not significantly changed or replenished during the crop -- most often water added only to replace seepage and evaporation.

STOCK IMPROVEMENT
Selective crossing/breeding of stock to achieve a genetic makeup that has certain pre-subscribed attributes such as faster growth, disease resistance, etc.

STOCKING DENSITY
Number of culture organisms per unit of area or volume depending on the system [e.g., organisms per m^2, m^3, are, hectare, gallon, litre, etc.].

TRIGGER
An event or catalyst that leads to a desired result.

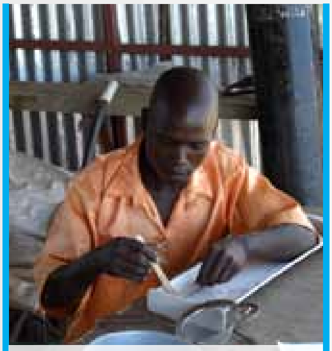
VALUE CHAIN
Considered by some to be a group of firms working together to satisfy a specific market demand, it can also be described as the sequential steps required from primary product to value-added consumer product. Aquaculturally, this refers to both the channels that deliver inputs [feed and seed] to producers as well as the conduits that deliver the products from these operators to the ultimate customer or consumer.

WATER BUDGET
The total water requirements for a specific aquaculture system to produce a specified product [e.g., the water needed to grow a crop of fish].

YIELD VS. PRODUCTION
In the context of the present discussions, yields refer to results per crop or harvest [i.e., kg/ha] whilst production refers to the annual cycle [i.e., kg/ha/yr].

01 > Introduction

Background



New and specialized skills are required as aquaculture becomes a commercial activity.

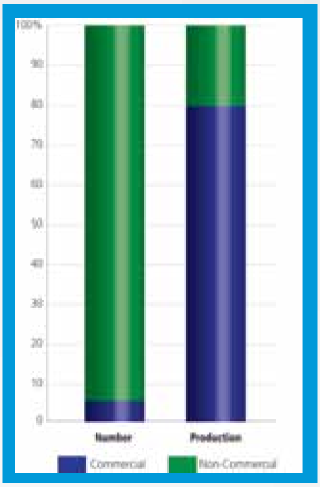
Aquaculture in the Africa Region has emerged from a little-known innovation into an acknowledged production system. However, a history based on donor-driven public-sector-managed projects focusing on aquaculture as a diversification tactic for smallholder farmers has affected expectations for, and investment in the sub-sector. For over fifty years, African aquaculture, principally fish farming, has been viewed by many as an advantageous mechanism for reducing risk and optimizing the use of on-farm resources. Within this context, aquaculture has, intentionally or not, often been marginalized as resources are redoubled for many other food producing systems. Public and private investment in the sub-sector has stalled; aquaculture being perceived as almost a hobby by some. As a result, whilst worldwide aquaculture has reached at par with capture fisheries in terms of supply of aquatic products, in the Africa Region production remains minimal, accounting for approximately two per cent of the global harvest.

Part of this benign neglect can be attributed to significant over expectations as to what aquaculture can do. In the 1960s and 70s, many saw fish farming as a panacea; albeit an endeavor targeting the subsistence farmer, often the "poorest of the poor". Small fishponds were repeatedly seen by promoters as nearly bottomless providers of fish for impoverished rural dwellers. Furthermore, given the resource limitations of this target group, early efforts to expand subsistence fish farming adopted structures that subsidized many services and fostered government dependence.

By the end of the 1990s, aquaculture was often seen with disillusionment; another failed effort. Millions of dollars had been invested in the sub-sector, yet the returns on this investment seemed poor at best. This publication aims to dispel this disillusionment, portraying a positive yet realistic picture of aquaculture's potential whilst encouraging well-targeted public and private investment in the sub-sector.

New Approaches

The view of aquaculture as a mechanism to diversify subsistence farming systems while improving household food security is not wrong. However, the systems that fit into this subsistence category will not fulfill the expectations of decision-makers that aquaculture make noteworthy contributions to national objectives for food supply and economic growth.



Schematic representation of the relative contributions of commercial and non - commercial aquaculture to national programmes in terms of total number of stakeholders involved in the category vis-à-vis the relative production from each category

Subsistence aquaculture, now frequently referred to as no-commercial, is an important and justifiable part of any national aquaculture programme. But, if it is not complemented by a commercial segment of the sub-sector, expectations will remain unmet. This understanding is at the core of new approaches to aquaculture development: there must be a duality to the a national programme to cater for both commercial and non-commercial groups. Commercial is equated with profitable and profit seen as a prerequisite for sustainability.

Analyses of many non-commercial systems indicate that the aquacultural part of the whole farming system reaches a state of equilibrium with regard to other farming activities; family labor availability often determining the point of equilibrium. Additional investment in the aquacultural component is unlikely to change this equilibrium unless there is a new technology and/or a social or economic shock to the family. Hence, as public services strive to increase efficiency of their delivery, seeking to see marginal increases in output for corresponding increases in input, it is difficult to warrant considerable investment in non-commercial systems. In many cases, the monitoring and support for this portion of a national programme may be most effectively accomplished by NGOs, CBOs or CSOs.

Aquatic product markets can be complex, with multiple layers that must be identified if a new enterprise is to be able to successfully sell its product.

Based on these analyses, the new approach to aquaculture development is to concentrate effort on those areas that provide the greatest returns to marginal increases in support. This implies both a geographic and technical concentration. Investments in aquaculture need to be made in geographical areas that have the best mix of socio-economic and bio-physical attributes so as to offer the best chances for success. Technologically, this needs to be accompanied by the use of tried and tested production systems. Cross-cutting this decision matrix is the requirement for responsible development and management; aquaculture investments needing to be socially and environmentally sound.

Targeting investments with a high probability of success includes engaging in all activities along the value chain from input suppliers [chiefly feed and seed] to processors and fish mongers. The depth of this chain demonstrates the need for wide support covering a broad spectrum of specialities in addition to fish husbandry: quality assurance, bio-safety and security, social responsibility, environmental sustainability, among others.

Targeting investments includes concentrating effort on carefully selected sites and individuals. Sites with the best possibilities for success must be chosen as well as investors who have the best chances to make these sites work. For the smallholder, this frequently requires establishing functional "**clusters**" of production where a group of small investors can achieve economies of scale by working together; pulling down services and attracting high-paying markets.


Quality seed is now a necessity


Farmers progressively rely on feeding


Technologies such as aeration are also used


SAMAKI CENTER
SAFE FARM PROJECT
BOX2020. K.K.
FRESH FISH JOINT
FOR
DAILY - KILA SIKU.
Fish at its best
Our Services includes

02 > Methodologies

Business Management

The new approach to aquaculture is based on the paradigm that, with a focus on commercial operations, aquaculture must be a viable business: an aqua-business. This understanding represents a significant shift in technical assistance requirements. Whereas early limiting factors were seen as being biological [i.e., identifying and disseminating the best technologies], it is now understood that bio-technology must be accompanied by effective capacity building in business and market planning and management.

This methodology applies to all scales of aqua-business: micro, small, medium and large [industrial]. Investors and operators must know how to undertake appropriate business planning before starting farming operations, whilst also being able to effectively manage the aquaculture enterprise as a sustainable for-profit business once under operation.

From the perspective of public aquaculture programmes, this methodology often translates into a prioritization for small- and medium-scale [SME] aqua-businesses. This is not to the exclusion of larger-scale [industrial] firms. The principle is that these larger firms, with access to considerably greater resources, do not need the public sector's support to get off the ground. Hence, for these bigger businesses, government's role is more one of facilitation, monitoring and regulation.

Market-Driven

Aquaculture products compete with those from capture fisheries

A business approach must be predicated on a thorough market analysis. All too often, investors seem to have had the the belief that "if you grow it, some one will buy it". This means that market analyses have been postponed until after harvest, if attended to at all. An important lesson learnt is that assuming the crop can be sold for a profit can be a fatal error. Markets must be evaluated and targeted at the very onset of activities, when the aquaculture venture is still a concept.

Market effects need to be taken into consideration when preparing the business plan: what size product will be raised and for which exact

Niche markets can be important


Operators often look to add value


Different size products for different customers

market? The answer to this question will determine the stocking density, harvesting techniques and other bio-management criteria.

All too often, at the planning stage, too little effort is devoted to examining the market options. As would-be investors often seem to think bigger is better, operators frequently intend to grow the biggest product, equating this with the largest profit. However, the inverse is regularly true; a smaller size means a shorter growing period, often more harvests per year. Even if unitary prices for smaller products are lower, an additional harvest each year positively affects the enterprises's bottom line.

It is worth recalling that the major impetus for investment in aquaculture is profitability and profitability for aquaculture enterprises has largely come about due to rising prices. A decade ago, with high operating costs for farms and relatively cheap capture products, few firms could compete in the marketplace.

It is also worth noting that, while at the beginning of the sub-sector's development, dramatically under-supplied markets may be considered as "limitless", when the sub-sector begins putting several thousand of tons of product on the market, there is a tangible effect -- most often prices falling. This then affects the ability of SME operators to enter the market.

Although high prices are obviously disadvantageous to consumers, they provide important incentives to investors whilst allowing for certain margins for error. New entries into the aquaculture field, undoubtedly beginning along a learning curve, are able to make some errs at high prices and still make a profit. As prices fall as production rises, this margin for error narrows, making it increasingly difficult for the SME operator to become established.

Need For Cash

A central divergence from earlier approaches is that the focus on commercial operations acknowledges implicitly a need for cash. Farmers at all scales will require varying amounts of liquidity to be able to pay variable costs of their operations. It is generally recognized, for example, that feed accounts for approximately two-thirds of the production costs. With feed costs in the Region ranging from around US$ 600/MT to over US$ 1,000/MT, financial arrangements are necessary if farmers are to have access to feed.

Fortunately, application of the aqua-business approach coincides with a growing availability in credit, especially micro-finance, for farmers in some areas. This is not, however, to say that credit is accessible. In spite of growing credit facilities, credit remains a severe challenge for most fish farmers; aquacultural credit even more difficult to obtain than general agricultural due to the perceived riskiness of aqua-businesses.

As production increases from a commercial approach, rural fish farms can no longer count on "on the pond bank" sales to move their product and must look for a variety of market options.

As market and business planning become essential prerequisites for establishing aqua-businesses, in some instances it has been seen that these prerequisites have been able to leverage credit for SME farmers who would otherwise have difficulties in securing suitable loans.

Seeking optimal returns would appear to be an aim of any enterprise. In most cases, this would seem to be the optimizing of financial returns: cash profit. However, there are multiple motives for undertaking aquaculture in addition to the generation of profits. Approvals to undertake fish farming may lead to access to land, water or capital. Fish farming may even enhance some one's social status or social capital. But, whatever the motivation, from the perspective of a national programme, verifiably profitable investments should be promoted irrespective of secondary benefits.

Verification is an important but often challenging task. It requires accurate and comprehensive data obtained through thorough record keeping. Good records are at the heart of any business. These data must be available for the entire value chain and administrative hierarchy.

03 > Investors

The Farmer

The farmer is the principal investor; investing time, money and other personal resources such as land and water. Fish farming is first and foremost about people; people investing in aquaculture. Fish farmers come from all demographics. Whilst the production component of the value chain is most often "gender neutral", both men and women raising fish with few cultural norms assigning this recent activity to one or the other group, processing and marketing tend to be dominated by women. In the present context, "the farmer" applies to all economic operators in the sub-sector and throughout the value chain, as often different operations along this chain are undertaken by the same people. The farmer should be at the core of any national aquaculture programme.

It is important to be able to target those investors who have the resources, both intrinsic and physical, to be able to successfully establish and manage an aqua-business. In many occasions, aquaculture has been propagandized as either a fashionable venture or an easy path to riches -- it is neither. And, it is important that newcomers to the sub-sector understand what established farmers know: aquaculture is hard work.

Farmers

Farmers




Work, and more often access to resources can be facilitated when farmers join hands. However, this generally does not mean collective or group management of an aqua-business; businesses of whatever scale should be individual endeavors. The Region has a long history of failed collective aquaculture ventures and these lessons of history should be heeded. Nonetheless, forming formal or informal structures [i.e., clusters] that allow smaller investors to achieve economies of scale is often the best tactic. These clusters can be officially chartered cooperatives or loosely knit groups. In whatever form, these structures should add value by increasing the economic power of members.

Farmers engaged in clusters and operating aqua-businesses are by definition commercial. Experience has shown that typically not more than 15-20% of non-commercial farmers will evolve into commercial operators. Most commercial fish farmers enter into the activity with the express intent of making money. These can be owner-operators or absentee owners, often entrepreneurs and retirees, who hire farm staff.

The Field Worker

Field workers are the facilitators with vested interests in the success of the aquaculture sub-sector. These change agents may be government extensionists, agents from NGOs/CBOs/CSOs or even private citizens who wish to make a contribution by supporting aquaculture. Like farmers, field workers may come from any segment of society. Whilst extension and outreach will be discussed in subsequent sections, the important matter here is that new approaches to profitable fish farming need to address field workers and information sources in terms of accessibility and quality.

The Consumer

The consumer may be king, but the consumer is also an investor, pushing and pulling the sub-sector. The shift to market-driven aquaculture brings the consumer much more directly into the management plans of the investor; consumers are becoming more discerning and demanding, producers must produce products that will attract customers and meet consumer preferences. These consumers cover an increasing scope from rural dwellers, urban residents and those relying on international markets. To all, quality and price are the central concerns.

The Decision-Maker

On behalf of their respective employers, decision-makers are intrinsic to the success of the sub-sector. Previously most decisions relied on government. Favorable operational and policy environments required a large dose of favorable political will. Albeit the political climate is still a critical element, the pivotal decision-makers have now expanded from the initial case of only the technical government agency driving the programme to a new situation where there is a multiplicity of influential parties; a consortium of government institutions (e.g., trade and commerce, local government, water, environment, land, etc.), business interests (e.g., bankers, millers, processors, vendors, etc.) and civil society (e.g., NGOs, CBs, CSO, etc.).

Producer Organizations

Key investors in the sub-sector benefit form economies of scale by joining hands and establishing associations or other collective organizational structures. These groups generally have two levels of function: lobbying for perceived benefits with decision-makers and organizing inputs and product markets to take advantage of the economies of scale they have engendered. Care must be taken to ensure that these groups, however, are composed of a majority of active stakeholders and not "armchair" aquaculturists who are too far removed from the realities of raising fish.

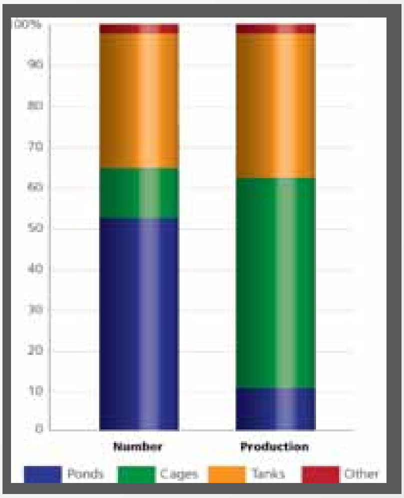
04 > Technologies

The following discussion on specific aquaculture systems and products will focus on finfish in fresh- and brackish water. Whilst these systems are the most numerous and economically important in the Africa Region, the marine environment should not be ignored. Mariculture is a very important component of several national programmes including Madagascar, Mozambique, Namibia, South Africa, Tanzania and Zanzibar as well as the Island States in the Region. Crops of seaweed, oysters [including pearl oysters], abalone, shrimp, marine finfish, among others, are very significant in the economies of these countries. However, the general principles discussed below are crosscutting for all production environments. Similarity, whilst there are a number of freshwater invertebrates that constitute aquaculture crops, in the interest of focusing the discussions, these organisms will not receive specific reference and the concepts presented for finfish will typically apply to other culture organisms.

Systems

Ponds

Pond systems are among the earliest employed. Ponds are generally earthen, constructed by hand or machine. Ponds have the advantage in that they represent an established skill-set. Techniques for siting and building ponds are widely known, although perhaps less widely applied. Ponds are not holes in the ground, but constructed structures where soil is cut, filled, compacted and shaped.



Relative contribution of major aquaculture systems in terms of number of stakeholders using these systems and the contribution of the system to overall production.

Ponds approximate a natural environment and provide varying degrees of natural food for culture organisms which can offset costs for purchasing feed.

Ponds can have water supplies that use gravity flow or rely on some source of energy for pumping. Equally, pond draining [harvesting] can be accomplished using gravity or pumps [including siphons]. Ponds are static water, requiring only replenishment for seepage and evaporation (this generally accounting to a total water requirement of 2-300% of the volume of the pond).

Ponds require significant areas of land and generally require that the investor has some form of legal ownership or access rights.

Pond culture is a function of the surface area; the interface which controls the absorption of dissolved oxygen upon which aquatic organisms rely for their respiration. Stocking densities are reported as individuals per hectare of water surface, or equivalent.

Pond systems are progressively relying on supplemental or complete feeds to be able to achieve profitable yields . Tilapia is the most common pond crop. Minimum acceptable yields are often in the neighborhood of 2 MT/ha [± 0.5 MT], whilst producers at the upper end of the scale report yields of three to four times this baseline depending on management and climatic factors.

Pond farms can range in size from very small [e.g., 0.05 ha] to very large [e.g., 200 ha]; the critical factor in design being profitability. As a general guideline, based on early experiences in Côte d'Ivoire, SME farms ranging from 0.25 ha to 1.5 ha proved to be profitable and within the resources of the smaller investor.

At low intensities [e.g., yields of 2-4 MT/ha], pond farms require competent but not highly-skilled management. Feed quality and availability is the first limiting factor in most pond systems as one attempts to intensify. As operators increasingly use commercially prepared complete or supplemental feeds, fish find feed accessible; feeding and defecating more. As more organic material enters the systems through feeding, oxygen to support the increasing biomass becomes the new limiting factor. At this stage, aeration [cf. photo pg 3] is necessary if further intensification is to be achieved. With growing intensification, operators move from stand-by/emergency aeration to full-time aeration. As the biomass continues to expand due to enhanced carrying capacities, the limiting factor swings from low oxygen to high nitrogen [a product of metabolizing the increasing load of organic material], at which point the system has reached its maximum for most operators of earthen ponds [i.e., at yields approaching 20-40 MT/ha]. As intensity increases, so do the management skills; highly intensive operations requiring highly skilled staff.


SON (Source of the Nile) Fish Farm, Uganda

Stocking densities are determined by yield [recorded or estimated] and target market size. For example, if the desired product for the market is a 200 g fish and the anticipated yield is 3 MT/ha, 15,000 fish would be stocked per hectare [1.5 fish/m^2].

To facilitate profitable SME pond systems, public or private promoters may choose to develop aqua-parks: suitable blocks of land that can accommodate a number of aqua-businesses. Concentrating these businesses on one high-potential site facilitates support and market access.


Pond farming is increasing in sophistication


Farms can be small enterprises.


They can also be of a larger, more industrial scale

Cages

Cage culture represents one of the most rapidly growing aquaculture systems in the Region. Although there had been isolated attempts for more than thirty years, significant business-orientated cage farming started in Lake Kariba in the late 90s using imported technology and cage design. The cylindrical high-volume cages [e.g., 19 m diameter and 6 m depth with 1,700 m^3] had already been used in Lake Volta and have subsequently been used in Lake Malawi/Nyassa. Medium-size cages [e.g., 6x6x6 with 216 m^3 or 4x4x4 with 64 m^3], often built in six- to ten-cage rafts, had been used for years in the lagoons of Côte d'Ivoire and have been adapted as one of the most-used designs in Lake Volta. High-density low-volume cages [e.g., 2x2x2 with 8 m^3 or 2.5x2.5x2.5 with approximately 16 m^3] represent more recently introduced technology first applied in Lake Victoria and now also adopted by some producers in the Volta Basin.

Although some exploratory cage culture has been done with catfish, effectively all current cage farming is of tilapia. Stocking densities [fish per cubic meter of water] depend on cage design and water quality as well as target market size and management practices. High-volume cages aiming at a 500-550 g fish stock up to 50 fingerlings/m^3. By comparison, medium-size cages under similar conditions could stock up to 100 fingerlings/m^3 while low-volume high-density systems could be stocking 350-500 fingerlings/m^3. Medium and smaller cages often target a harvest size of 200-300 g. At these densities, large, medium and small cage would yield, on average, 25, 30 and 100 kg/m^3.

In juvenile/fingerling cages of any design, where the biomass of fish is very small in relation to the volume of water, stocking densities are generally in the order of 1,500-2,000 fish/m^3. Cage mesh sizes for fingerling activities are smaller, affecting water exchange.


Tropo Farms, Ghana

The spacial arrangement of cages is also an important factor. Whilst high-volume cages are inevitably single units which must maintain a suitable distance between each so as to mitigate possible discharge impacts, medium- and small-size units are often attached for ease of management. Albeit rafting these cages was common practice, an alternative sequential arrangement, like a necklace of cages with open water on all four sides of the cage, has been found to give superior water exchange at the cost of slightly less accessibility. Although internal water quality control is the principal factor to consider in locating cages, cage siting must be done in due consideration of the local environment both in terms of environmental impact and possible risks of damage to the cages due to seasonal storms or prevailing winds and currents.

Whilst, to the casual observer, cage culture may seem as an easy system, it is indeed very complex and more demanding than pond farming. Cages themselves are subject to catastrophic losses. Cages maintain fish at higher densities which raise behavioral issues as well as concerns for maintaining good animal health. Cages are located, in most instances, on common property, where perceived adverse environmental impacts due to discharge of potential pollutants is a frequent concern. Cages have been accused of causing "visual pollution" by some tourist industries. Cages may be more susceptible to theft and predation. Cage systems are intensive systems and do require a corresponding level of skilled management. These systems also require good quality complete feeds; the preference being an extruded [floating] feed, although sinking feeds can be used if good feeding techniques are employed.

These possible handicaps notwithstanding, cages are the subject of much of recent investment in the sub-sector with important operations [i.e., annual production > 1,000 MT/yr] on Lakes Kariba, Malawi/ Nyassa, Victoria and Volta coupled with interest in Cahora Bassa, Tanganyika and the Niger System. These investments can at least partially be attributed to cage culture's comparative advantages of; (i) suitable sites available on under-utilized lakes and reservoirs whereas competition for suitable land-based sites is very keen in many areas; (ii) water available at "no cash cost"; (iii) investing in cages is generally less than in other systems in terms of dollars invested versus tons harvested; (iv) cage systems are easily scalable, being suitable for a variety of investment levels; and, (v) cages are moveable, able to be moved to different locations or even taken physically out of production.

The aqua-park methodology can also be applied to cages; an area of a water body zoned for a certain volume of production from a group [cluster] of SME cage operators. This structure has an added value that it facilitates SEA analyses of environmental impact.


Mid-size cages in rafts


Individually moored large cylindrical cages


High-density low-volume cages in "necklace"

Static Water Tanks

Static water tanks are another important production system, nearly exclusively devoted to catfish farming. The epicenter for these systems is Nigeria where, in the aggregate, thousands of tons of catfish are produced from a multitude of small-, medium- and large-size concrete tanks. Although some "tanks" may be over 2,000 m^2, most range from 12 to 20 m^2. A common design in Nigeria is a cement block tank built on a concrete slab, 8 m in length, 2 m wide and 1.2 m high for a total water surface area of 16 m^2. Management guidelines include stocking 10-15 cm catfish fingerlings at an initial density of 125 fish/m^2. As these fish will exhibit differential growth and larger fish are cannibalistic on their small siblings, the fish need to be graded at least once a month for the first two months to remove the larger predatory individuals. At the end of this process, having removed the larger fish and experienced approximately a 20% mortality, the final catfish density should be in the neighborhood of 33 fish/m^2.


Obasango Farms Nigeria, Ltd

The catfish can be fed a variety of feeds from local mixtures to high quality high-protein complete diets. However, growth and water quality will be affected by the quality of the feed. Top-of-the-line feeds [i.e., 40+% protein] costing approximately US$ 1,500/MT are used by many producers to try and optimize operations -- achieving a product of over a kilogram in size after five to six months. Some farmers feed high-protein high-cost imported feeds for the first half of the harvest cycle when the growth response is the most acute; shifting to lower-cost local feeds for the second half of the cycle.

Depending on management, production from these systems can vary from 15 to more than 30 kg/ m^2. Although the "one kilo plus" size was the target of farmers until recently, as the price of these larger fish as a luxury product is relatively high, some farmers are now targeting 400-500 g individuals.

Production is a function of density and density affects the water management employed. Some producers report changing water every three to four days to ensure adequate water quality whilst others exchange much less frequently. If water is changed five times a month, for example, for a six month harvest cycle, total water requirements for a tanks would be 3000% of its volume.

Tank farming is relatively straight forward, requiring only modest skill levels. However, marketing is evolving into a major challenge as the market for the typical fresh whole one kilo plus product is becoming saturated and farmers now looking at a variety of value addition options; smoking being the most often chosen.

Whilst these tank systems can be built in many locations, the key factor is the market for catfish -- most other fishes not able to support the substandard water quality that develops in the static water tanks. This water quality, moreover, may be one of the future issues affecting the tank industry. As the effluents from these systems have high organic loads, their impact on the waters receiving the discharge will need to be assessed and possible mitigating measures put in place.


Catfish in tanks are voracious feeders


Typical small static water tanks


Middle-size catfish tanks

Others

There are a wide variety of other aquaculture systems in production in the Region. These include relatively capital and technology intensive systems such are recirculating models which reuse water. The major factor with regard to these systems is their complexity; they employ more sophisticated technologies that can require both specialized equipment and staff. Investment costs in these systems are high. For every "hi-tech" system that succeeds, there are a score that have failed. The input requirements for most of these systems, including energy, are costly and often not very suitable to settings where there are unreliable utilities, mediocre maintenance and poorly developed service sectors.

Mining facilities with aquaculture potential after decommissioning

Typically, the high operating costs of these capital intensive systems are reflected in high prices for their products. In markets supplied by relatively cheaper capture or culture products, these systems have seldom been competitive. However, with rising prices for aquatic products, these operations are becoming more economical. Inasmuch as these systems can be self-contained [recirculating] and are high intensity [high density], they are frequently suitable for being put in enclosures (e.g., building, greenhouses, etc.). This feature is an important comparative advantage under situations where full control is required [e.g., in urban areas where there are concerns about pollution] and/or where it is necessary to undertake environmental control [e.g., in cooler areas of the Region where ambient temperatures, either due to altitude or latitude, are sub-optimal for the species concerned and the water must be heated].

These systems may also be appropriate where the products are very high value. An example of this is the abalone industry in South Africa which is very capital and technology intensive, but also profitable as it produces a luxury product. Consideration has also been given to these systems for producing value addition commodities such as processed fish products [e.g., fish paté or other speciality products].

Another scenario whereby more intensive systems may be practical options is where aquaculture is a by-product of some other industry. An example of this is the mining industry which has identified aquaculture as a possible post-mining activity to support local economies after mine decommissioning. Such plans include not only undertaking cage culture in open mine pits, but also using decommissioned infrastructure to grow fish, such as sedimentation ponds.

Before leaving this topic, it should not be interpreted that the only alternatives to ponds, cages and tanks are recirculating systems. There is a long list of other production systems including pens, raceways and a wide variety of culture mechanisms for different species such as shellfish, algae, ornamental fish or crustaceans.


Circular concrete "ponds" for tilapia at Dominion Farms (Bondo, Kenya)


Bio filters for recirculating catfish system at Durante Fish Industries (Ibadan, Nigeria)


Modified raceways with recirculation and to be covered by greenhouses at Chambo Fisheries (Blantyre, Malawi)

Species

Major Culture Organisms

Although there are hundreds of known culture organisms and many more still to be identified, in the Africa Region there are relatively few widely cultured species. Whilst some see this small number as a negative factor, in the present context it is a positive attribute. A limited number of common culture organisms means that most national programmes across the Region are dealing with the same products and, accordingly, that technology is highly transferable.

The principal finfish farmed in the Region, as seen through the preceding discussions on systems, are tilapia and catfish. These fishes may be of various taxonomic groups. Amongst the tilapias, the ***Oreochromiids*** dominate, with ***O. niloticus*** the most popular followed by ***O. mozambicus*** and ***O. andersonii. O. macrochir, O. shiranus, O. karongai*** and ***O. aureaus.*** From the genus Tilapia, the major culture choices are ***T. zilli*** and ***T. rendall***i. Finally, for the genus ***Sarotherodon***, ***S. melanotheron*** is the most frequently used in brackishwater culture.


Tilapia (above) and catfish (below) are the major culture organisms for most investors in aqua-businesses

For the catfish, ***Clariid*** fishes are the chief culture freshwater organism, with ***Clarias garipineaus*** the most common choice. Heterobranchus is also cultured as is the hybrid with ***Clarias*** [hetero-clarias]. For brackish waters, ***Chrysichthys*** is cultured.

Trout (generally ***Oncorhynchus mykiss***) is becoming a potentially important species in the highlands and cold parts of the Region. Trout was introduced to many areas during the colonial period, but established a foothold in Kenya, Tanzania, Malawi and South Africa. For some years, South Africa has had a commercial trout industry, most often using flow-through tanks. More recently, successful cage trials in the highlands using high volume cages have led to plans for up to 6,000 MT of trout production from Lesotho.

Stock Improvement

Aquaculture is perhaps the last animal husbandry industry to invest significantly in stock improvement programmes, and the Africa Region the last place to acknowledge the essential importance of improved stock if African fish farmers are to be able to compete with their counterparts from other regions. Years of reliance on poorly managed public hatcheries have resulted in a negative selection whereby, according to some reports, farmers using seed from these hatcheries will find the fish producing 20% less well than if they had gone to the wild and collected seed. At the same time, results from breeding programmes indicate the improved strains can perform at least 20% better than wild stocks; overall, a minimum anticipated gain of 40% for farmers being able to grow improved fishes.

At the onset, it is imperative to underline that stock improvement is a result of selective breeding and not genetic modification; improved stocks are not GMOs.

The need for stock improvement programmes appears obvious. But, these programmes are demanding. Stock improvement requires specialized technicians and facilities. Stock improvement requires reliable support and funding.

Because of the requirements for effective stock improvement, it should be seen as a long-term commitment and undertaken when the resources to fulfill this commitment are available. Moreover, because of the nature of these resources vis-à-vis the operating budgets of most national government agencies, these programmes are most realistically undertaken on a sub-regional basis; a single center supplying improved stock to group of countries.

Although a number of public institutions and larger farms have undertaken improvement programmes, and these may have demonstrated increased performance, these have been relatively ephemeral as the exigencies for an effective programme require a long-term commitment and resources.

The major effort in the Region to date has been the selective breeding of ***Oniloticus*** in Ghana, where more than a decade of selection has resulted in a fish with demonstrated superior performance (Box to right). Plans have been made for breeding programmes for ***O. niloticus*** in other areas as well as for other tilapias and ***Clarias***. However, the resource requirements have heretofore delayed implementation; the Ghana programme serving as the pioneering effort for the Africa Region.

The Akosombo Strain

In 2003 the Ghana Water Research Institute of the Council for Scientific and Industrial Research (CSIR-WRI) began efforts to develop improved tilapia seed by reviewing the performance of different strains of Oreochromis niloticus in the country. With the identification of higher-performing parent stock through these exercises, a formal breeding was initiated. As of the end of 2011, this programme had produced seven generations. The most recent generation of what is known as the 'Akosombo strain' now demonstrating 20% faster growth than the parent stock.

Stock improvement programmes run hand-in-hand with seed dissemination programmes. Once improved seed is available, it is necessary for it to be monitored for the protection of both the farmer [counterfeit suppliers entering the market once it is appreciated that better seed offers higher prices] and the environment [fish movement a concern that requires oversight]. This monitoring and certification will require establishing channels and mechanisms for the supply of improved seed.

In the aqua-business paradigm, the seed supply system should be a private venture although the stock improvement programme itself is, at least initially, a public activity. This private supply system entails a set of seed multiplication facilities; probably a network of private hatcheries that have received improved brood stock from the breeding programme and that, in turn, provide seed directly to farmers or provide fry to a network of smaller nurseries that ultimately supply farmers.

An important dimension of seed multiplication and dissemination is the issue of "risk". This will be discussed in more detail below in the section on environment.

Management

Management refers to both the business management of the aqua-business and its markets as well as the bio-technical management of the system and its fish. Whilst business management follows the best business practices, much as they would be applied to any other investment, the bio-technical management for fish farming is unique, requiring specialized skills and inputs. Aquaculture management has frequently been noted to be strongly affected by the access to five basic inputs: quality and affordable feed; quality and affordable seed; adequate capital; quality information; and, suitable markets. Whilst these form the backbone of an aqua-business, there are also requirements for social, environmental as well as legal and regulatory resources if the farm is to be sustainable and properly managed.

Feed & Nutrient Resources

Among the five basic inputs, feed and seed are often the most challenging as they are specific to aquaculture; the capital, information and market requirements similar to those for other agricultural enterprises. Seed supply has been introduced in the preceding sections. From a financial perspective, however, feed is a major issue; feed typically accounting for the majority of variable costs required to put the fish on the market.


Although feed may come from local providers, imported feed is an important input for many programmes

Fish farming feeds, aqua-feeds, can be of various forms and qualities. In the most basic context, one would talk of nutrient inputs such as fertilizers, both organic and inorganic, that stimulate natural food supply. Many mechanisms have been tried to provide sufficient nutrient inputs into a system to achieve profitable production levels without investing in expensive processed feed. Probably the most successful of these have been the integration of fish into other animal husbandry production systems whereby the fish benefit from by-products from the other enterprises. This is most suitable in cases where there are already profitable livestock enterprises [e.g., pig or chicken] and fish are inserted to make use of wastes.

A major factor in many management practices aimed at increasing food supply through organic fertilization is the opportunity cost of gathering the fertilizing materials [e.g., manures and compost].

In spite of the considerable effort invested in studying "non feed" options, trends are definitely moving toward the use of commercially produced complete or supplemental feeds [the former providing all the nutrient requirements of the cultured organism whilst the latter are generally lacking in some essential ingredients which are taken care of through other food sources]; complete feeds for cages and tanks whilst pond systems may use either.

As feed is an important investment and profitability is directly related to feed quality and price, the general principle is that aqua-business operators should use the best available product at the cheapest price. This implies open access to global feed markets.

There should be no imperative that feed supplying national programmes comes from national suppliers. As the industry matures, these suppliers will establish when the opportunities are present.

Food conversion is an essential concept. It refers to the amount of feed that must be consumed to produce a given weight of product (e.g., a conversion, or FCR, of 1.5 means that it takes one and a half kilograms of feed to produce a kilogram of fish). In general, this is an inverse relationship: the higher quality [more expensive] the feed, the lower the food con-version. Most commercial systems aim at keeping the FCR below 2.

A rule of thumb used by many practitioners is that farm-gate prices should be at least three times the feed cost (e.g., feed costing $0.80/kg should derive prices of at least $2.40/kg]. Conversely, if farm-gate market prices are $3.60/kg, the producer should not pay more than $1.20/kg for feed, all costs included.

There are evident links between aqua-feeds, the feed milling industry in general and the overall agricultural sector. Countries that have agricultural enterprises that produce surpluses are well placed to use these surpluses for milling animal [including fish] feeds. However, most countries in the Africa Region do not produce surpluses.

Land & Water Resources

It is obvious that aquaculture systems require land and water resources; the quantities and qualities needed depending on the systems. Historically, the Africa Region has been viewed as one of the last frontiers with vast un- or under-used land and water resources. There are many references describing the great untapped resource base that could be used for aquaculture. However, this picture is changing; rapidly in some areas.

In many parts of the Region there is keen competition for land and water; some areas already clearly demonstrating critical shortages of both key resources. Complex land tenure and inheritance systems, increasing sales of large tracts to investors, speculation and burgeoning populations are all changing the scene and making what was once abundant scarce.

These changes notwithstanding, there are still areas of the Region with ample land and water resources. In these situations, it is often best to seek to increase output through expanding the area in production rather than intensification. Each level of intensification increases both the costs and risks. Nonetheless, in sites where expansion is not feasible, in-tensification may be necessary.

In areas where water is rationed, the primary motive for building fishponds may be for water storage for other crops. Similarly, increasing awareness of the need for water storage has led to growing numbers of impoundments [small water bodies] which can be stocked to develop a capture fishery, managed as a culture-based fishery and/or used for cage culture.

Multiple use of water resources is one option to address competition. The principle is to use the same volume of water for different productive functions; ideally in the same space. The best example of this is rice-fish culture where fish are grown as a second crop in rice paddies. These systems have reportedly been successful in Asia. However, their successes in Africa have chiefly been seen in Madagascar where rice-fish is a common practice using carp. There are few successful examples of profitable rice-fish outside these Madagascar experiences, albeit these options may be advantageous to non-commercial farmers in rice growing regions. Other designs, with fishponds up- or downstream from irrigation schemes, have proven to have greater profit potential.

Social Resources

Although sometimes not part of the discussion, social resources are central to successful aquaculture operations. These include the dimensions of social capital and social responsibility.

Aquaculture has been highlighted as a sub-sector that can provide relief to the ballooning youth unemployment crisis that is seriously impacting on many African countries. The socio-economic benefits of fish farming notwithstanding, these expectations need to be put in proper perspective. The requirements for entry into the sub-sector, as discussed above, often pose severe obstacles to the would-be young investor. Additionally, traditional land tenure schemes can add another hurdle, as some make access to land very difficult for young men and women. One of the realistic options for minimally impacting on youth employment, in areas where aquaculture is practiced in hand-dug ponds, is to train youth construction "gangs". This has proven successful in Côte d'Ivoire, Ghana and Kenya.

Aquaculture requires specialized skills. From the entry level of laborer to supervisory positions, fish farm staff must have training in proper handling and management of fish. Hence, social programmes that wish to link to an expanding sub-sector should address these skills development needs.

Theft is an oft-cited problem, more problematic in some systems than others. Yet, experience has shown that operators who are socially conscious and work within prevailing social and community structures are much more successful and have dramatically fewer problems with society in general. This also applies to the concern over possible friction between fishers and cage operators; pre-start-up investment in social and community engagement will build important resources.

These social resources are equally important when aqua-farmers need to address core issues of access to resources [land and water], compliance with regulations [traditional and legal], and marketing of products.

Environmental Resources

In the broadest sense, the environmental resources include the total set of bio-physical and socio-economic assets: ecological, economical, social, institutional and financial. This holistic approach is inherent in the relatively recent Ecosystem Approach to Aquaculture (EAA). In many instances, at policy level EAA is seen as the umbrella that should guide the sub-sector. In practical terms, this has provided a convenient package to envelope approaches that have been evolving over past years and have ultimately led to the current business-orientated paradigm.

EAA is broad spectrum, embracing the various elements listed in the previous paragraph. Although it could rightly be considered as a methodology to ensure sustainable integration into the whole environment, the term environmental, in common usage, refers much more to safeguarding the ecology.

The ecological resource required for fish farming is principally water. This water must be contained, or the fish contained in a larger body of water, and its quality maintained. Some systems also require land, sometimes large areas.

Increasingly, aquaculture is rightfully being held to a higher standard in terms of its impact on these resources. In spite of the desirability of setting high environmental standards, the realities as they relate to the Africa Region are that these now global standards were progressively built in other regions, based on trial and error as well as lessons learnt. In the aggregate, this has resulted in a set of best practices such as those embodied in the Code of Conduct for Responsible Fisheries (CCRF). However, these standards, established over a long period in other geographic areas, are being applied wholesale to the lagging Africa Region. This means that, unlike their counterparts in other parts of the world, African investors are frequently held to global standards from the onset of their operations.

As aqua-businesses establish in countries, there is a growing awareness of the sub-sector that is attracting the attention of environmental agencies. In some cases, these initial relationships have been tenuous at best. Whilst environmental control and monitoring agencies have the mandate for ensuring sustainable and responsible resource use, they often have little understanding of aquaculture as a specialized activity. When, however, solid partnerships are formed between the fisheries and environment agencies, there can be effective synergies.

One of the challenges is turning words into practice. Albeit most countries have environmental rules and regulations that apply to the sub-sector, these have heretofore rarely been applied. With growing visibility of the aquaculture sub-sector, these edicts now are becoming part of the process in spite of the fact that they may be hard to administer, posing difficulties for both the implementing agency and the farmer.

Environmental Impact Assessments (EIAs) are one of the tools routinely applied to fish farming. EIAs pose two challenges; they may not be specifically designed for aquaculture and they may be costly. These concerns can be particularly burdensome for SME investors when the processes are long and expensive. One option for assisting the small investor is to designate aquaculture zones [aqua-parks] and require a Strategic Environmental Assessment (SEA) for these zones, thereby reducing the costs to the individual operator.

At the heart of much of the environmental discussion is the issue of "risk". What is the real risk or threat posed by aquaculture? Aquaculture unquestionably has demonstrated negative environmental impacts in some situations and there is need to minimize the risk of these occurring. These negatives range from destruction of critical ecosystems such as mangroves, spreading diseases that affect aquatic organisms, degrading water quality to introducing exotic organisms. Hence, the risk cannot be removed, only mitigated.

This involves a delicate set of decisions and processes that need to balance the needs of the environment with the realities of aquaculture. Regardless of the precautions, one must assume fish will escape from aquaculture facilities. These fish can be moved about by people, birds or other animals. These fish can escape if there is an accident during transport, a tear in a cage, a broken levee, or a variety of other unforeseen happenstances. In spite of laws in some countries forbidding the movement of fish between major ecological basins, these remain difficult if not impossible to control.

At the same time, we are to some extent the victims of our own technology. As we are now able to describe the genomes of different fish populations, it is no longer the fact that fish is of a different species that can make it an exotic; it can be considered as a "genetic exotic" when its gene frequencies differ significantly from those of wild populations; some raising the specter of these different genes effectively having the same potential negative impact on bio-diversity as the introduction of an exotic species.

The aquacultural realities are that is it not feasible nor conceivable to have isolated breeding and seed multiplication mechanisms in every major basin. For a variety of practical reasons, fish seed must be transferred between basins and across ecological and geo-political boundaries if the sub-sector is to become established as a major contributor to national and regional objectives. Resolution of these issues is a work in progress.

Legal & Regulatory Resources

As can be seen in the preceding paragraphs, upsizing aquaculture sub-sectors are correctly being subject to increasing scrutiny from all quarters. This requires a set of legal and regulatory resources that will accomplish the necessary task of enforcing responsible management without making undo hardships for the investor, especially the SME farmer.

Ideally, this implies adjusting the prevailing codes, best practices and legal guidelines to suit the local environment. Such fine-tuning will ensure appropriate surveillance, but it is expensive and requires a variety of actors with a good knowledge of the technical specializations of the aquaculture sub-sector.

Investors need to be educated about the prevailing rules and regulations whilst also needing an expedited process for entry into fish farming. It has frequently been proposed that governments establish "one-stop-shops" that educate the investors as to the process and help complete the necessary procedures

05 > Programmes

National aquaculture programmes can be classified in two categories: progressive and incipient. The former represent country programmes where aquaculture is an established, if modest component of the national economy. For ease of reference, progressive programmes will be considered as those where aquaculture contributes at least 5,000 MT annually to the national supply of aquatic products. By default, incipient programmes are those producing less than 5,000 MT annually.

This bi-modal classification of national systems is certainly not absolute, nor is it intended to imply that all countries in the Region would fall into one or the other category. As has been stated in preceding sections, one cannot undertake aquaculture everywhere. For any given set of systems in the sub-sector, there are prevailing bio-physical and socio-economic requirements. Some of these requirements can be overcome [e.g., skills, production inputs, markets]. But some requirements relate to the prerequisite environment. These demands are difficult to overcome [e.g., water, temperature, soils]. It therefore is to be expected that some countries will not be suitable aquaculture candidates. This reality must be understood and accepted. Aquaculture is not necessarily an option for all countries. As technologies and economies change, places that had minimal aquaculture options may find themselves with more choices. Nonetheless, at any point in time there are places where aquaculture is simply not a viable option.

The following sections discuss issues relating to the national programmes for those countries with suitable aquaculture options; be they progressive or incipient. The discussion will also expand to the supra-national [sub-regional, regional or global] analysis where often economies of scale dictate that action be undertaken at multi-country level.

Role of Government

Facilitator vs Producer

Government was the major catalyst for aquaculture development in the 70s and 80s. Government programmes, often supported through extra-budgetary donor funding, were all-inclusive. Frequently based at government stations, these programmes typically provided extension support, training and subsidized inputs of feed and/or seed. In a classic case, aquaculture extensionists, based at project-supported stations and traveling by project-purchased motorcycles, worked with groups of subsistence farmers: introducing aquaculture, selecting sites for development, providing seed, following-up on management and helping with harvesting.

These early government-centric programmes fostered a dependency predilection in beneficiaries -- the public sector fully driving the processes including producing inputs and in some cases food fish for markets. Whilst the philosophies of these top-down methods may well be considered today as ineffective, the major factor effecting sustainability was the nearly complete reliance on extra-budgetary funds. Inasmuch as these systems promoted aquaculture as a "good" choice and not as a profitable business, the sub-sector made no discernible contribution to national aims and was hence seldom entitled to any measurable portion of national budgets; fish farming projects were supported by donors with severely limited, if any core funding.

The noteworthy decline in donor support of fish farming in the 90s led to a conundrum: aquaculture activities needed to be abandoned or recast in such a way as to make meaningful contritions to national objectives whereby core funding could be justified. In cases where recurrent budgetary support could be secured, this was at modest levels; public programmes no longer able to carry on all segments previously paid for by donors. These realities encouraged a shift in approach where Government changed from producer to facilitator. Under this new role, an effective aquaculture private sector was necessary to benefit from the facilitation offered by a restructured public sector.

Outreach

Outreach includes extension and other information channels. Quality outreach has proven to be one of the most difficult functions to sustainably provide. Many formula have been tried but few have endured.

Outreach remains a core responsibility of the public sector; albeit the sole propriety no longer rests with Government. Over the years, as public extension services have become more and more stressed, facilitation has increasingly come from no-public sources. In some cases, this takes the form of private consultants. Whatever the source, the main concern is the quality of the advice being offered or purchased. There is a proverb that states an expert is anyone fifty kilometers from home. Unfortunately, the sub-sector is fraught with numerous "experts" who are technically charlatans; they have little of value in the message, but are able to deliver it with mastery such that it is taken up by would-be aquaculturists. This is not to tarnish the position of all change agents. Many are doing fine work. But, there is a need to provide some mechanisms to be able to monitor the quality of information dissemination.

Private information providers include NGOs and CBOs. The same quality assurance issues apply in these cases. As the variety of information sources increases, it becomes progressively valuable to design national networks that can link to ANAF; enhancing the quality and quantity of information available to an expanding audience.

Education & Research

Education and research are also continuing services that should be supported, and supported well through the public sector. Whilst there is some private investment in research and education, this should be as part of an integrated public-led programme and not a segmented and disjointed mosaic. To a large extent this requires central coordination. This coordination can be facilitated by national and supra-national networking as that promoted through ANAF. In both domains, a critical concern in terms of efficiency is territoriality; all too often certain groups want to bolster their own institutions or territories by providing some aura of exclusivity. This is counterproductive. The aquaculture sub-sector is small at best and efficiency can only be achieved through truly coordinated programming obtained through full collaboration. This requires orchestrated inter-agency, inter-institution and inter-personal action that targets common problems; solving these through the most expedient means. In practical terms, this requires consolidating education and research activities; often having a few lead centres at national or supra-national levels.

Government Infrastructure

As stated, public infrastructure historically was at the heart of many national programmes. These facilities [stations, centres, hatcheries, mills, etc.] were perceived as being essential components of the programme, consuming a large part of the available resources.

In hindsight, these facilities have more often than not been a drag on the development of the sub-sector. The stimulus provided by public infrastructure was short-lived at best. For a variety of reasons, over the medium-term, government stations were not able to provide high quality inputs to farmers. In numerous situation these centres became ends in themselves with more energy devoted to maintaining questionable facilities than establishing a sound foundation for private-sector-led fish farming.

It is not appropriate at this juncture to enter into a thorough analysis of government facilities; many such evaluations exist and have demonstrated that the roles for such infrastructure in today's operating environment is quite modest. There are valid functions [e.g., research, stock improvement, brood stock management, etc.] for public infrastructure. These are, however, limited, require focus and consolidation where the services rendered are to an adequately large constituency to offset operating costs.


Modern but under-used hatcheries


Public pond and training facilities


Ultimately, public stations often un-used

Capacity Development

South-south cooperation is an opportunity to kick-start capacity development in the Region

An expanding aquaculture sub-sector requires increased human resources in both the public and private sectors. As government programmes shift more into a monitoring and surveillance mode, there are entire new skill sets required in addition to more traditional extension and outreach capabilities. There are similar needs for enhanced capacity in the private sector. One of the prominent needs is for qualified farm managers. As farms become more productive, using more advanced technologies, it is increasingly necessary to have technically proficient managers. However, few countries have in place the prerequisite training facilities and programmes to be able to produce the needed managers.

Overall, whether for government services or private farms, practical hands-on skills are the most in demand. These, however, need to be balanced with an increasingly specialized and technical team of individuals who can address the complex issues relating to such topics as aquatic animal health, genetic introgression, risk analysis and internal rates of return.

It is important to recall that a pillar of the new approaches to aquaculture development is the hypothesis that there are more commonalities than differences across country programmes. These common denominators mean that capacity building can be done at a broader geographic scale. This commonness is also conducive to widespread applicability of technologies imported through such schemes as south-south cooperation.

Private extension providers can render important services when qualified and accessible to farmers

There are few inherent major differences in African aquaculture programmes that require highly localized skills or techniques; basic principles and good practices are what is most needed across the spectrum of technical and oversight staff and employees. Building and reinforcing these basic skills on a large scale can be facilitated by regional and sub-regional networking through such mechanisms as ANAF.

Services

Today services are generally a private sector venture. Certainly service providers for inputs of feed, seed and capital should be part of the private sector. Although there is not universal adoption of this practice, there are many examples of why the public sector should not be engaged in this level of support.

Feed suppliers [services] are mills. These can be unsophisticated local millers producing relatively mediocre products or state-of-the art industries producing high quality feeds with full complements of micro nutrients. The key is that the feed should fit the system; farmers having access to the most suitable feeds at the best possible price.

Seed suppliers are hatcheries and nurseries. As with feed mills, these cover a wide spectrum of enterprises from rustic to high-tech. As well, as with feed, the principle is to match the seed supplier with the requirements of the specific system in question. There is no *"one size fits all"*.

Services constitute businesses. Expanding aquaculture services expands the positive economic impact of the sub-sector.

Information services are more obtuse. To be effective, these need to be housed in effective public-private partnerships. On the one hand, much of the necessary information originates from the private sector. On the other hand, reliable public sources are necessary to counter possible fictitious private "expertise".

As national programmes evolve and embrace increasing numbers of private service providers and producers, credible coordination of these programmes becomes an increasing necessity, and this in the domain of the public sector.

National Strategies & Plans

The preceding discussion cover topics that should all be the elements of national strategies and plans. Since 2003, the preparation of these cardinal documents has been adopted by a growing number of African countries. To briefly reiterate, strategies describe the ways and means to reach policy targets. Strategies describe the roles and responsibilities of the various stakeholder groups comprising, answering the questions "who" and "how"? Strategies are "living" documents that change with the evolution of the sub-sector. Plans are more detailed than strategies; going down the continuum from general to specific. Plans add the components of "where" and "when" to those elaborated through the strategy. Plans occupy a distinct and identified period of time, a given plan replaced by a new plan as opposed to being up-dated as is the case with strategies.

Policies are the umbrellas containing a series of strategies [green arrows]; these in turn with their own specific plans [red lines]

Strategies and plans should be crafted and guided by a national aquaculture advisory group that is composed of representative stakeholders with a majority membership being the private sector and civil society. This group, with a formal mandate from Government, ensures that the design of the sub-sector is in concert with the ways and means of the operator and service provider as well as being in line with Government priorities. This group must be too small enough to be functional (e.g., generally less than 15 member). To accommodate the diversity of most national programmes, it can be complemented by a group of associate members or resource persons and institutions.

Monitoring & Evaluation

M&E have typically received limited attention. These processes are expensive and require specialized skills. Nonetheless, these functions are fundamental if the sub-sector is to move forward and should be important parts of all national aquaculture programmes.

Although there are many commonalities to the regional aquaculture programme, and technologies applied elsewhere are often applicable in the African situation, as processes become increasingly detailed and fine-tuned, there will surely be important local variations. These will be identified and articulated through effective M&E functions.

Regional Dimensions

Given the aforementioned hypothesis of commonalities between and across national programmes, aquaculture has a high degree of regionalism. This phenomena offers a comparative advantage to the sub-sector. Given the sameness across the Region, research results have wide geographic applicability, curricula can be used from one country to another, innovations can cross-pollenate and services can be provided to multi-country units. However, to benefit from this advantage, there must be a high degree of intra-regional collaboration accompanied by effective regional networking.

Regionalism implies that continental or sub-continental institutions for education, research and outreach can be effective; reducing the unit cost by serving several constituencies at one time. Regionalism also opens door to the regional political economy as sub-regional economic communities [RECs] are one of the important blocks in many current development efforts.

Regional aspects and advantages are best encapsulated in regional networks such as ANAF. Networks open trans-boundary information channels that favor regional approaches, strengthen supra-national institutions, expand access to verifiable information and forge multi-country partnerships between stakeholders from the public and private sectors as well as civil society.

Global Dimensions

As important as regional linkages are to the development of the sub-sector, aquaculture is a global market and, if African producers hope to fully integrate, they must globalize. Traceability and adherence to best practices are becoming criteria for accessing high-paying global markets. Organic markets offer opportunities for some African producers. Whilst globalization may not seem to be, however, a dimension that affects all production systems, one needs to consider both the global export and the import channels. Importations of relatively cheap Asian farm-raised products into African markets are offering serious competition to local producers.

Partnerships

Local, national, regional and global programmes require partnerships reinforced through coordinated collaborative effort. With growing visibility and political good will, the aquaculture sub-sector is attracting attention from a wide variety of actors including investors, civil society, development partners, advocacy groups along with political leaders. For both the benefit of stakeholders and to optimize efficiency, these different individuals and institutions should work in a mutually reinforcing manner. However, territoriality, competition for resources and differing methodologies [often in spite of an overarching national strategy in principle reuniting the sub-sector] can often fragment effort and confuse practitioners by providing even conflicting messages.

Simple tilapia hatcheries supply large numbers of fry

Modern mills producing extruded feeds

Catfish hatchery supply large geographic area

SPADA

INVESTING IN THE FUTURE

ANAF

Aquaculture Network for Africa

06 > Conclusion

Aquaculture is a business.

Aquaculture as a set of food production systems, as an investment and as an employer can make beneficial contributions to national and household economies under favorable conditions. But, aquaculture cannot be practiced everywhere. If suitable prerequisites are not available, it is not a wise investment.

Aquaculture is market driven. Product and inputs markets must be carefully analyzed before investing.

Aquaculture is regional; blending national and regional action will provide the least costs for the highest returns.

Aquaculture is global. Aquaculture has acknowledged global responsibilities for mitigating potential negative impacts whilst optimizing positive attributes.

Aquaculture programmes in Africa need to expand. The social and environmental aspects of this expansion are critical.

Targets

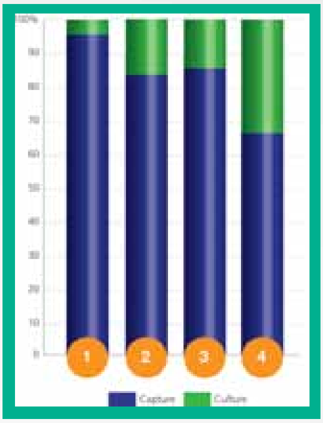
Aquaculture is production based. With ballooning populations and stagnating supplies from capture fisheries, the demand for aquatic products is rapidly increasing. A growing portion of this demand should be met by farm-raised products. It is suggested that within five years 30% and 10% of domestic fish supply come from aquaculture for progressive and incipient countries, respectively.

Triggers & Drivers

"Nothing succeeds like success." The major trigger for expanding aquacultural production is profit. Heretofore many endeavors have been faith-based; impressive yields and profits predicted by experts prompting the smallholder farmer, small investor and large entrepreneur to invest time and money in farming fish. Many times these efforts have not met expectations.

A ***successful cluster*** of producers and service providers will stimulate (trigger) replication; promoting investing and garnering political support.

Success is equated with ***profit*** coming from expanding production. If real financial profits can be achieved through farming aquatic products, the sub-sector will grow.



Five-year targets: relative contribution to national fish supply from capture and culture sources; (1) incipient programme, current situation, (2) progressive programme, current situation, (3) incipient programme, future [target] situation, and (4) progressive programme, future situation

An accompanying trigger is ***products*** in the ***markets***. As consumers see acknowledged farm-raised products increasingly in the market, they will accept aquaculture as a major supplier. This will further build the market and reinforce political support.

These triggers need to be driven by inputs and processes that become integral parts of an expanding [progressive] national aquaculture programme.

To make money you have to have money. Accordingly, access to ***credit*** may be seen as a prerequisite and an essential driver. To a large extent, this requires convincing lending institutions of all sizes that aquaculture is bankable.

It may be intuitively obvious, but for an enterprise to succeed, the required inputs of ***quality and affordable feed and seed*** need to be available. These inputs are core drivers for the sub-sector.

Supporting production and market triggers, there is an important ***information*** driver. This relates to information at all levels; strong and visible producer associations, mention of fish farming in popular press and telecommunications as well as robust links with sub-regional and regional networks such as ANAF.

Information ***per se*** will not complete the picture. It is necessary to deliver these ***information*** products to users. This requires effective ***outreach*** -- a necessary and challenging driver. Outreach is the two-way flow pattern that builds capacity in beneficiaries but provides critical feedback for monitoring and evaluation.

Closely allied to the networking driver is its sister: ***functional producer organizations***. Organizations of active producers bolster the political support for the sub-sector and increase the efficiency of production, especially for SME operators.

Cutting across these areas is the driver of functional and effective ***partnerships***. These transform mediocre or even conflicted programmes into synergistic movements that can rapidly move the sub-sector forward by optimizing the returns on resources invested.

A final transversal galvanizing agent is ***developing the needed capacity***. This does not imply wholesale training or a flourishing of tertiary academic programmes. This driver relates to developing skills to fill identified gaps in such areas are farm and hatchery management.

Way Forward

In many ways, success is magnetic; it attracts more investors, many of whom will also be successful. The hard part is getting the the first part right. This means minimizing the risks and maximizing the chances for success: start with the best sites and the least challenging technologies where the market is assured.

On the edges there are many innovations and possibilities for new and appealing enterprises. Whilst one definitely does not want to stifle innovation, at the current early stages of development, using tried and true technologies at sites that have the best possible match of socio-economic and bio-physical criteria favoring the system in question is the best tactic.

With pilot self-sustaining profitable clusters firmly in place, these can be used as the foundation for building a larger and more diverse national programme. As this programme grows, the economies of scale will change and more services will be attracted to support the producers.

At regional level, as successful farms are solidly established in countries with the highest potentials, these serve not only as domestic models but also as models for adoption across the Region. This progressive transcontinental adoption of successes the core of SPADA.

Precautions

Establishing a new sub-sector is a challenging task. As can be seen from the preceding discussions, this has many dimensions and many actors. A significant amount of time is necessary to make preparations and to educate different key stakeholder groups. The risk is that once political will is nurtured and attracted, political imperatives often want immediate results. This leads to over expectations. This leads to growing pressure to quickly produce results and, as necessary, cut corners. However, trying to circumvent the evolutionary nature of the processes and jump-start the sub-sector on a poorly built foundation, as has been done in the past, will not lead to long-term viable aqua-businesses supplying products to the country's markets. Precipitating action will, in all probability, lead to a few short-lived extravaganzas that appease the political imperatives, but that then fade away and leave an aquaculturally impoverished national programme.

Annex I: Yield

From Tacon, A.G.J. Feeding Tomorrow's Fish: Keys for Sustainability, Rome: FAO 1997.

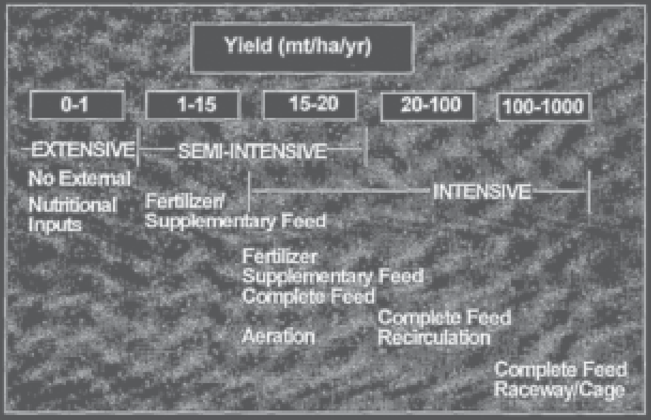
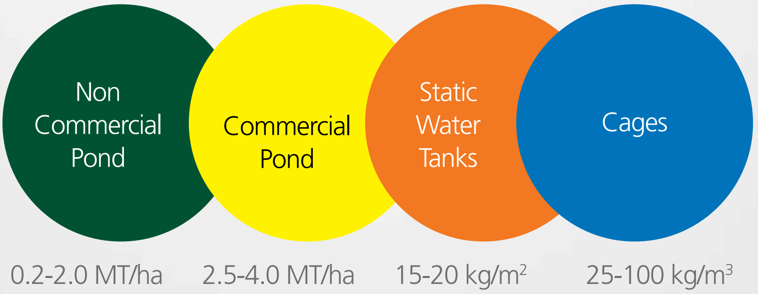


Fig. 5. Intensification of farming systems and feed management options (modified after Edwards, 1993).

The figure above presents one version of yields attainable from different aquaculture systems. It has converted all systems to units of mt/ha/yr. However, these are perhaps misleading as the units of measure may be more applicable to pond systems than other. The schematic below presents alternative yields [per crop/harvest] for different systems.



Annex II: ANAF

The Aquaculture Network for Africa was established in 2008, modeled after NACA [Network of Aquaculture Centres in the Asia-Pacific]. ANAF aims are:

(A) Foster Collaboration and Linkages

- To foster fruitful collaboration among aquaculture institutions in Africa
- Aquaculture information technology networking system developed in Africa
- Remove the compartmentalisation of activities at sub regional level
- Establish and strengthening sub regional structures

(B) Knowledge Management

- To learn aquaculture from each other (experiential and cross learning)
- Create a knowledge based aquaculture institutions in Africa
- To know what is happening in the field of aquaculture in other African countries

(C) Information Gathering and Dissemination

- To collate and catalogue existing information
- To transfer information to other areas in Africa
- Fill in information gaps between African nations highlighting successes leading to avoiding wheel re inventing
- To facilitate sharing of information and cross learning among fish farmers
- Better circulation of results and information to accelerate the continent's development

(D) Research and Development

- Identify areas for research
- Coordinate and share experiences (feedback) on aquaculture research and development in Africa
- Identify gaps that hinder development and look for solutions to the identified problems.
- Develop infrastructure for networking at the institutional level

Annex III: SPADA

The objective of the Special Programme for Aquaculture Development in Africa is to improve economic and rural development by enhancing fish supply and distribution as well as benefiting nutrition through increased aquaculture pro-duction; this goal will be achieved by promoting sustainable aqua-businesses at national level including the necessary public and private support services. Specifically, the programme will strive to:

1. Increase aquaculture production in the Region by at least 200% over the next decade;
2. Assist two-thirds of countries in the Africa Region in elaborating and implementing national aquaculture development strategies with accompanying aquaculture plans, legislation and regula-tions;
3. Implement the Code of Conduct for Responsible Fisheries (CCRF) and Best Management Practices (BMPs) as they relate to aquaculture as well as instituting monitoring and evaluation methods that ensure social and environmental soundness;
4. Strengthen the Aquaculture Network of Africa [ANAF] to facilitate information exchange, provide technical assistance, co-ordinate education and research and provide basic support to the sector while employing the latest information technology including communications technology to facilitate networking and information exchange; and,
5. Facilitate access to inputs (e.g., feed, seed, capital, land, water) by investors while promoting intra-regional trade and markets for aquatic products. The programme will cover all African countries and be directly linked to NEPAD through its Action Plan. SPADA activities will take place at national, sub-regional and regional levels. At national level the programme will work with public and private institutions, service providers, NGOs/CSOs and the private sector to establish sustainable and responsible aqua-businesses which will, in turn, increase employment, fish supply and investment opportunities. Working through national, sub-regional and regional governmental organizations, as well as NGOs/CBOs, the principal counterparts of the programme will be the private sector producers. Accordingly, the project is a one-time catalyst to open the way for achieving the outputs specified above and not part of support to a recurrent public sector programme. In this context, sustainability is evaluated in terms of the long-term increase in fish supply from successfully producing farms with beneficial social, economic and environmental contexts.

The programme will be active in seven arenas:

I. *Strengthening Regional, Sub-Regional & National Institutions*. SPADA will provide capacity building and advise as to how to efficiently structure aquaculture institutions at all levels as well as provide training on a broad spectrum of aquaculture issues ranging from aqua-business management and production to facilities development. It will assist with the elaboration of national development strategies, plans and adjusted legal frameworks that enable increased investment and production.

II. *Networking & Outreach*. SPADA will strengthen ANAF and build effective links to extension and outreach activities at all levels including producer organisations involving local farmer "clusters". These activities will include publicising information concerning opportunities in aqua-business to encourage investment in the sub-sector, as well as successful examples of the impact chain from the policy level to access to financial and production inputs, processing and marketing. Websites, discussion fora and use of the latest information and communications technology will facilitate the tasks.

III. *Capital & Input Supply.* SPADA will assist in ensuring access by private investors to critical inputs including, among others, loans/investment, capital, feed and seed. This would include certification programmes for the suppliers of such inputs as feed and seed to ensure quality and traceability. As the aq-uaculture sub-sector expands, access to essential land and water issues will become increasingly competitive.

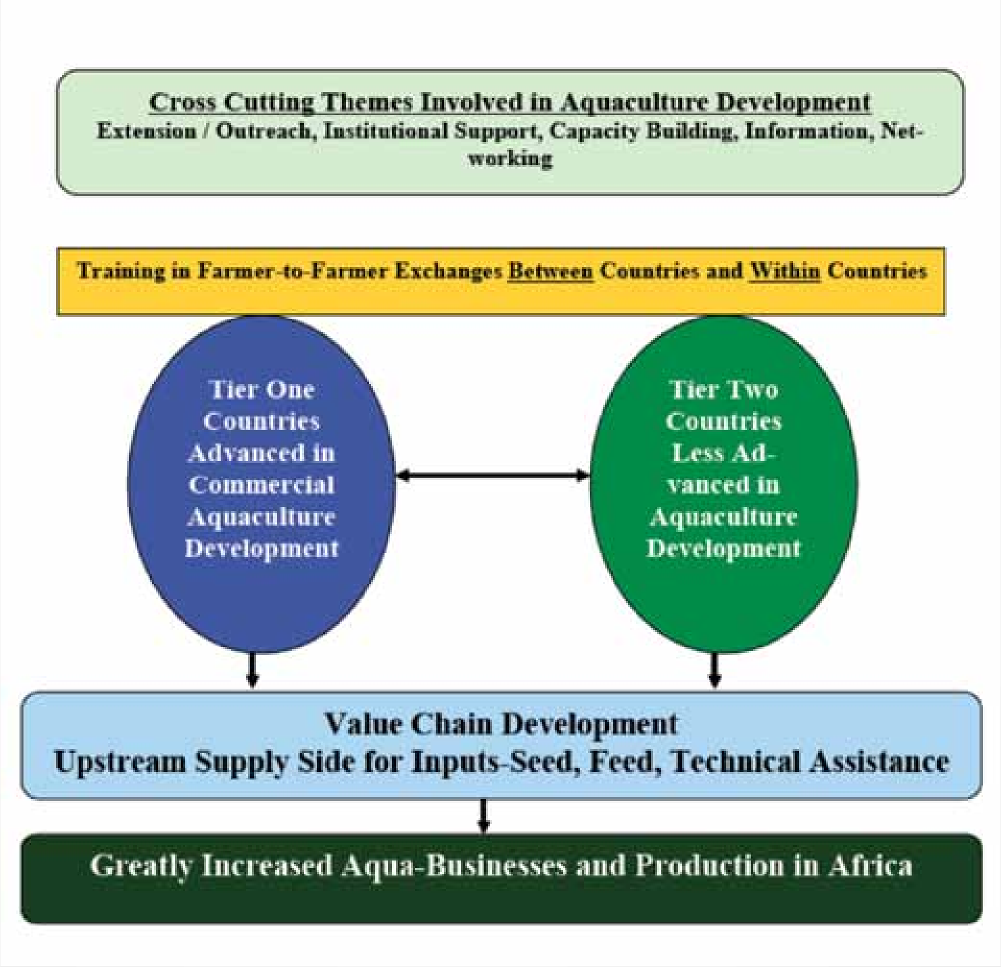
IV. *Processing & Marketing.* SPADA will provide guidance as to options and methods for processing and marketing including establishing quality control programmes. Adoption of standards and labels along the value chain will improve access to domestic, regional and export markets.

V. *Research & Education.* SPADA will focus on proven technologies, co-ordinating and harmonising research and education programmes in the Region to identify comparative advantages for different research and education institutions, support regional research and education programmes, match needs with providers and generally increase the overall efficacy of these operations.

VI. *Social, Economic & Environmental Soundness* SPADA will establish baselines and targets that are conducive for sustainable aqua-businesses as well as determining elements to be considered for pre-investment impact assessments and post-investment impact assessment and monitoring.

VII. *Monitoring & Evaluation* The programme will implement regional and national monitoring and evaluation activities including improved and more precise statistical reporting mechanisms. Partners will be supported to access appropriate tools for planning, priority setting, monitoring and impact assessment.

SPADA relies substantively intraregional cross-fertilisation. Countries are categorised as "Tier One" or "Tier Two"; the former relatively advanced in a specific aquaculture system and the latter less advanced. Farmers and other practitioners from Tier Two countries participate in practical on-farm capacity development in Tier One countries sand then return to their homes to train more operators [schema below].


Cross Cutting Themes Involved in Aquaculture Development
Extension / Outreach, Institutional Support, Capacity Building, Information, Networking
Training in Farmer-to-Farmer Exchanges Between Countries and Within Countries
Tier One Countries Advanced in Commercial Aquaculture Development
Tier Two Countries Less Advanced in Aquaculture Development
Value Chain Development
Upstream Supply Side for Inputs-Seed, Feed, Technical Assistance
Greatly Increased Aqua-Businesses and Production in Africa

TRIGGERS AND DRIVERS FOR ESTABLISHING

A PROFITABLE AQUACULTURE SUB-SECTOR

Aquaculture is growing in importance across the Africa Region. As part of renewed investment in agriculture given its pre-eminence in economic growth and food security in most African countries, the aquaculture sub-sector is being high-lighted as the likely source of needed aquatic products as supplies from traditional capture fisheries stagnate and even dwindle. This new importance attributed to the sub-sector, with the corresponding high expectations, requires new approaches to aquaculture development if new aims are to be achieved.

This document attempts to summarize new approaches to aquaculture development; approaches based on five decades of experience and linked to the new realities of today's global economy.

This document is not a manual for developing aquaculture. It is rather prepared as a reference for public and private sector decision-makers and investors to provide insight and guidance as to how to catalyze the growth of the sub-sector. Its aim is to set realistic expectations and outline effective processes that can lead to the sub-sector achieving its goals and making significant contributions to national, regional and global markets whilst undertaking responsible and stainable practices.

Following the summaries of new approaches, the document attempts to derive practical conclusions about the way forward for the aquaculture sub-sector in Africa; identifying specific triggers that will foster sustainable expansion and integration of the sub-sector into national economies.

The document may be considered by some to be sequel to CIFA(A) Occasional Paper 28: Guiding principles for promoting aquaculture in Africa -- benchmarks for sustainable development (Moehl, Brummett, Kalende and Coche, FAO, 2006).

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