Delegation of the European Union to Uganda

Republic of Uganda

Delegation of the European Union in Uganda

Beneficiary Framework Contract EA/127054/C/SER/multi
Lot 1: Rural Development

Request No. 2012/298807 - Version 2 20 November

Feasibility study to design, cost and operationalise model commercial Aquaculture Parks in Uganda

Source of the Nile LVHD cages

Final Report
January 2013

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Poseidon Aquatic Resource Management Ltd
Member of COWI Consortium

Delegation of the European Union in Uganda

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Report Quality Control certification

As per the COWI Consortium procedures, this report and its content has been proofread and controlled for quality against the Terms of Reference of the assignment, and their subsequent possible modifications.

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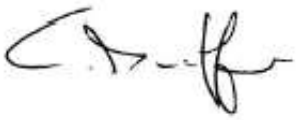

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Background

Uganda has significant potential for development of a commercial aquaculture industry. However, despite the policy intention and the obvious physical potential, there are few examples of profitable aquaculture businesses in Uganda. A previous study, completed (by Poseidon/Cowi) for the EU Delegation in 2011 identified a number of key constraints on the development of the sector. The study suggested that one potentially very important solution would be the development of 'Aquaculture Parks', which could be government-owned developments providing basic infrastructure for fish farmers, similar in concept to business parks.

The recommendation forms the principal background and justification for this feasibility study with the objectives to:

- Propose the adaptation of APs concept into Uganda's context;
- Assess the suitability (design, cost and operating) of the Aquaculture Park concept in Uganda at two sites to be availed by the Ministry of Agriculture Animal Industry & Fisheries (MAAIF); and
- Assess the market for Uganda's aquaculture products at the National, Regional and International level.

The work, undertaken by a 3 person team in Uganda in November 2012, had an overall approach consisting of three phases: data collection, analysis & concept development and reporting.

The Aquaculture Park Concept

An Aquaculture Park is similar to an industrial estate in the sea (or large lake), wherein aquaculture plots are leased to investors/aquaculture farmers and infrastructure, utilities and technical services are provided by the government or a private investor. There are a number of benefits ranging from these different models for clustering, which include:

- *Improved Planning and management of aquaculture development;*
- *Encouragement for the development of small to medium aquaculture production businesses;*
- *Cost savings and economies of scale; and*
- *Diversification into aquaculture by fishermen and rural communities.*

The above benefits are expected to address the constraints to aquaculture development identified in Uganda and the issue of over-fishing in various water bodies.

Lessons were drawn from the experiences of Aquaculture Parks and nucleus estate models elsewhere in the world (particularly the Philippines and Indonesia respectively) as well as Ugandan experiences of successful large-scale aquaculture (Source of the Nile), co-management structures (Beach Management Units) and co-operative organisation (WAFICOS and the UCA).

These all informed the development of the cage-based and pond-based Aquaculture Park Models proposed below, which should follow these guiding principles:

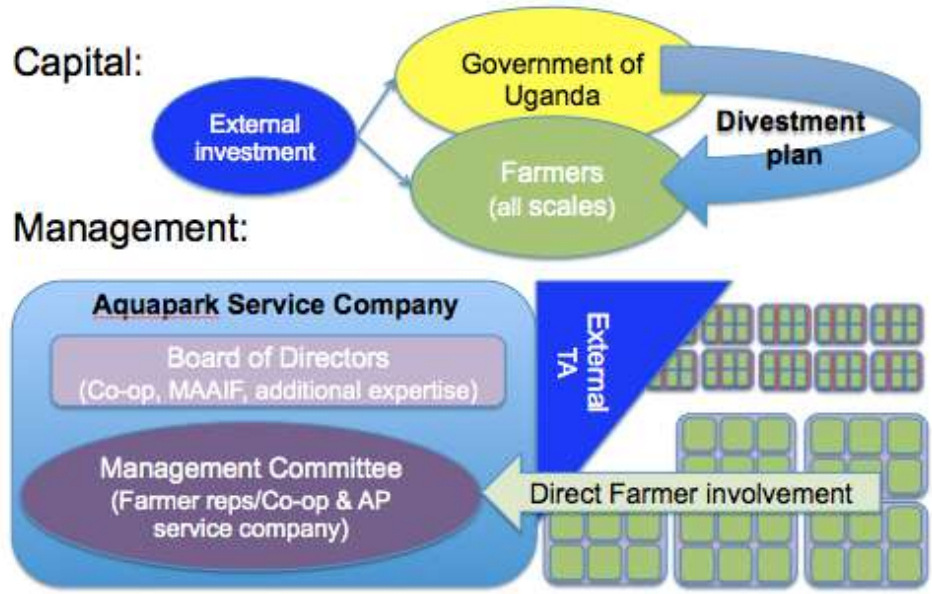
- An ecosystem approach to aquaculture
- Transparency
- Co-management
- Adaptive management
- Gender Equality
- Good quality Feed
- Good quality Seed
- Continuous Technical Support and Guidance

The culture systems proposed were based on the natural resources available (lake or land), production capacity (i.e. tonnage), rates of return and a target minimum income level of USh. 1,000,000 per month for smallholders.

Aquaculture Park Business Model

A Public-Private Partnership (PPP) approach is favoured with the Government of Uganda establishing an Aquaculture Park Company. This may be in association with a large-scale private sector partner that directly invests in the park or is paid a fee by the government to produce within the park on behalf of the government (the nucleus estate model).

Figure 1 Aquaculture Park Company structure



A share offer (open to prospective farmers initially) would recoup a proportion of the capital costs and provide working capital for the farm (purchase of equipment, feed, labour, etc. ahead of revenue from production). The Government would provide the Aquaculture Park Company with a long-term lease and all necessary permitting for site production to an agreed level.

The Aquaculture Park Company would consist of a board of directors, providing regular strategic oversight of the company. The day-to-day management of the Aquaculture Park Company would be driven by a management committee involving the Aquaculture Park Company senior management and farmer representatives and/or co-operative staff. This would ensure direct farmer involvement in management of the farm to instil a sense of ownership by the farmers.

Substantial technical assistance (TA) should be provided in the first 18 month to 2 years of Aquaculture Park establishment. This TA should involve those with direct practical experience of successful Aquaculture Park establishment and operation.

The Aquaculture Park would gain revenue from:

- Sales of fingerlings from an on site hatchery (modelled at cost of production +10%);
- Sales feed imported in bulk or made on site (modelled at cost of delivery or production +3%);
- A service charge of 3% of estimated yield per production area; and
- A marketing charge of 5% for fish harvested and sold through the Aquaculture Park.

The scale of production planned for the cage based park (3,000t) and the pond-based system (2,380t) are less than the 5,000t per site proposed in the Terms of Reference. The proposed scale of production is nevertheless far larger than any current operation in Uganda and will require phasing. Once the proposed production is well established, satellite production systems benefiting from the Aquaculture Park infrastructure could be introduced (more readily for the cage-based system, carrying capacity permitting).

Based on the proposed charges, the breakeven level of production for the cage-based Aquaculture Park is 600t (around 20%) and 1,120t (close to 50%) for the pond-based Aquaculture Park. At full capacity the Aquaculture Park Company (owned by the farmer investors) provides good profit levels (78% for cage-based and 51% for pond-based Aquaculture Parks).

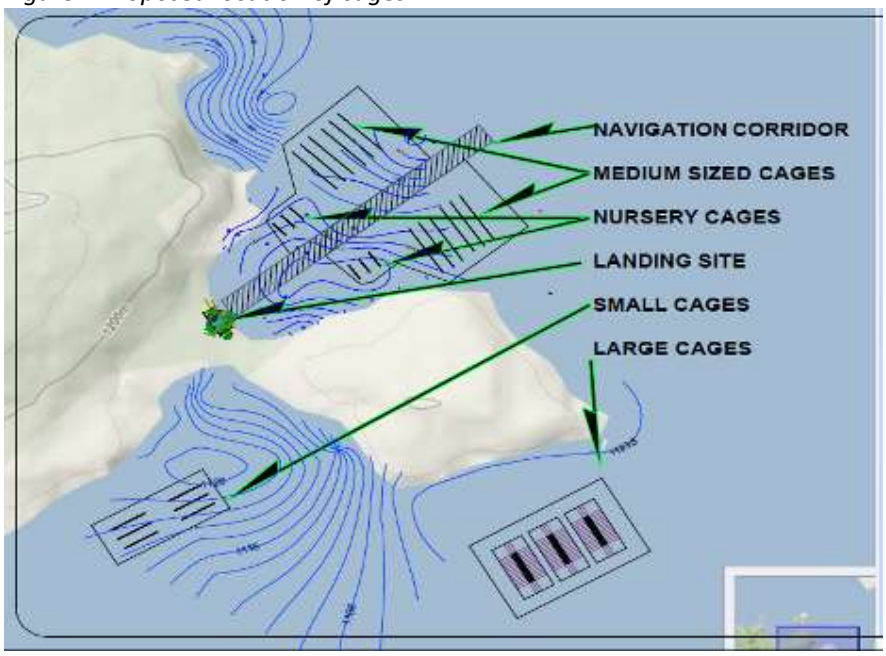
These generic business models were further developed for two specific Aquaculture Park sites, one a cage-based system in Lake Victoria (Mwena), the other a pond-based system on the banks of the River Nile (Apac).

Cage-based Aquaculture Park: Mwena

The cage-based system is designed for Tilapia production using differing scales of cage depending on available water depth.

A landing site near Kalangala on Buggala Island, called Mwena and the associated infrastructure was chosen for consideration in the technical and economic feasibility study. A landing site at Mwena Bay recently received significant investment in infrastructure under an ADB fund, but is currently unutilized. It has a number of infrastructure elements that could be used for the Aquaculture Park. Depth sampling in Mwena Bay and beyond identified adequate water depths for the proposed small, medium and large cages (an indicative layout is presented below).

Figure 2 Proposed location of cages

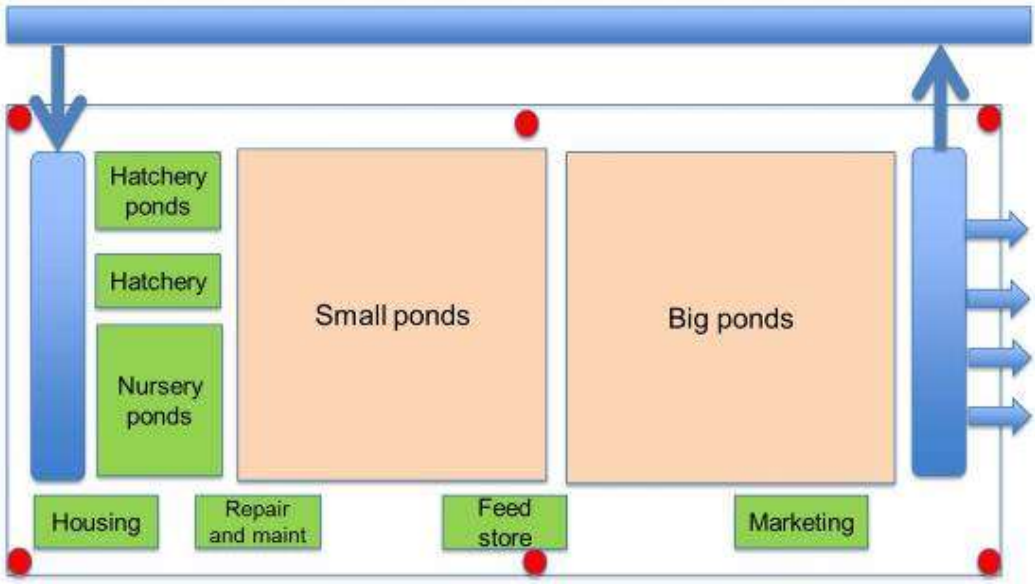


The site is also within close proximity of the ferry landing from Entebbe, one of two major points of exit from the Island to the main land. The other ferry landing located in Bukakata for the ferry operating between the Island and Masaka district is 32km away from the Mwena site. None the less, the road network on the Island is relatively good and sufficient to service an existing oil palm growing and refining industry.

Pond-based Aquaculture Park

The pond-based system is designed for both Tilapia and Catfish production, or in combination. The scale of production requires access to water from a permanent water body such as a lake or most likely a river. The river provides a vertical change that can be used to flow water through the park. It also provides the possibility of a hydro-power scheme to reduce pumping costs to a reservoir, which would be a significant operational cost for a pond-based Aquaculture Park.

Figure 3 Schematic layout for pond-based Aquaculture Park



One potential location for the pond-based Aquaculture Park is on the banks of River Nile, where it leaves Lake Kyoga north of Masindi Port. A number of potential areas on the south-eastern bank were proposed in the Apac district.

The pond-based system would require significantly higher capital investment than the cage-based system and take longer to construct with more difficult phasing. As the full capacity park would require a 200ha site, the availability of sufficient suitable land is identified as another constraint to establishment of a pond-based system.

At the request of MAAIF, a further site for a pond-based system was explored near Lira where dams had been constructed for rice cultivation and irrigation schemes. These schemes, dependent on seasonal rains, did not present the opportunity for establishing a large commercial scale Aquaculture Park, but showed good potential for developing a smaller scale community-based Aquaculture Park. This would introduce fishponds at the head of the dam, providing nutrient-rich water to irrigate crops downstream of the ponds.

Comparison of cage based and land based models

Analysis	**Mwena cage based Aquaculture Park**	**Apac pond based Aquaculture Park.**
Planned annual production	3,000t	2,380t
Estimated cost to build	8.2bn USh (existing Mwena site reduces this cost to 5.6bn USh)	9.6bn USh (using MAAIF pond construction, not commercial rates)
AP Generating revenue from a variety of sources (seed and feed sales, marketing fee and a service charge) at full capacity	79%.	51%
The break-even point	600t (20% of capacity).	1,120t (47% of capacity)
Time taken for construction	1 year	2 years
Direct Jobs created	280	400
Profitability with production assumptions based on improved culture practice at different scales of farmer*	7% for small scale, 28% for medium scale 40% for large scale.	19% for small scale 31% for medium scale 38% for large scale
With the reduced borrowing for capital investment	Small-scale investors achieve a positive NPV indicating it is worth investing in the park.	Unlikely to be open to small-scale farmers. Groups of farmers, potentially under a co-operative structure are more likely investors.
Profitability for the medium-scale investor.	comparatively low investment costs and good profits.	Positive NPV with good returns.
Profitability for the large scale investor	Substantial capital costs in shares and cages (positive cumulative cash flow in year 6); the park represents a long term investment. 68% IRR after 10 years.	Production Investment is at a lower level than the cage-based model (positive cumulative cash flow in year 4). 53% IRR after 10 years
AP Returns on investment (based on 50% of company	achieved after 10 years at Mwena (13 years in the model case).	While investment in the AP company should provide re-

Analysis	Mwena cage based Aquaculture Park	Apac pond based Aquaculture Park.
profits being distributed to shareholders)		turns in the long term, the IRR after 10 years is -6%.
Notes	A more positive outcome would be achieved with quicker phasing of production.	It should therefore be considered as providing access to the benefits of operation within the AP

*profitability estimates do not include additional income for farmers through ownership of shares in the Aquaculture Park Company.

The scale of the Aquaculture Parks and the multiple enterprises they contain result in the Aquaculture Park developing into a significant local employment hub with 280 estimated for a cage-based park working at full capacity and nearly 400 jobs in a pond-based park. There would be additional employment and wealth generated for nearby enterprises providing services to the Aquaculture Park as well as the wages spent in the local community. This is exemplified in the Mariculture Parks in the Philippines where it was estimated that for every person in direct employment in the Park, there were 1.4 person equivalents also employed.

Planning and management of Aquaculture Park Development

A development framework is proposed that would establish an Aquaculture Park Management Unit (APMU) within MAAIF to lead the implementation of Aquaculture Parks. This would support the work of a National Aquaculture Parks Committee. MAAIF shall be responsible for the following:

- Regulation and support of all aquaculture production activities and practices
- Research and Development of Aquaculture Production Systems and Technologies
- Provide all AP farmers public sector support and guidance.
- Register producers and provide training, allocation of Aquaculture Parks user rights (leases)
- Ensure tax exemption for aquaculture inputs and materials as per other agriculture inputs
- Technical backstopping supervision and monitoring
- Provision of infrastructure for production and marketing
- Serve as one stop centre to facilitate investment by investors and securing the required licenses and permits for Aquaculture Parks
- Serve as a registry for aquaculture investors and entrepreneurs
- Secretariat and Membership of National Aquaculture Parks Committee

Sustainability

The Aquaculture Parks must be sustainable and the following environmental management was proposed and explored by the team:

- Carrying capacity estimation for AP zone
- Environmental Impact Assessment (EIA)
- Environmental Management Plan
- Regular Environmental monitoring
- Synergies and compatibility for utilizing waste water for irrigation purposes specific to river fed, pond based system.
- Addition of Nutrients to Lake Victoria
- Distinguishing farmed and wild Tilapia
- Good Aquaculture Practice and Standards

Marketing

- The Aquaculture Park Company will manage the marketing of the product. In this way farmers can benefit from the production and marketing expertise of a larger organisation, without feeling they are simply contract growers.
- Quality will be assured on all outputs from the AP through tight control of harvest procedures and post-harvest handling in temperature controlled and hygienic conditions.
- The high production standards proposed for the park presents the opportunity to develop a high quality brand for Aquaculture Park fish
- Initially the Aquaculture Park is expected to supply the buoyant regional markets where demand is outstripping supply.
- Regional traders are currently purchasing from multiple producers throughout Uganda.
- The aquaculture park will enable a consistent supply at a single point of collection for quality assured fish, making it very attractive to wholesale buyers.
- Larger sizes suitable for filleting and the growing demand for value-added products, particularly for catfish, suggests that linkage with processors could also be advantageous.
- Growing the Ugandan market for farmed fish should be part of any market strategy and wider development of the sector using market promotions and awareness-raising to explain the benefits (nutritional and environmental) of Aquaculture Park farmed fish.

Funding options

- Funding options explored include the EU Equity fund, production grant schemes such as Sawlog and commercial loans for small and medium scale to invest in the Aquaculture Park.
- Larger scale investors are identified from within the aquaculture sector in Uganda and overseas (China, Norway, etc.).
- The AP model also provides an opportunity for potential investors from outside aquaculture to diversify into the sector as a high level of technical assistance is proposed along with continued MAAIF support to the venture. Existing large-scale agricultural companies such as Mukwano and Bideco should therefore be approached in addition to aquaculture interests.
- MAAIF should work with Uganda Investment Authority to develop a prospectus for potential investors of all scales. The availability of credit at more preferential rates to current commercial credit should also be explored with funding institutions.

Recommendations on Aquaculture Park development

It is recommended to:

- Progress the Mwena cage-based Aquaculture Park as it can be quickly implemented and the capital cost for implementation is lower and the profitability higher than for the land-based Aquaculture Park at Apac.
- include a budget of 5.6 billion USh in the next National budget to establish the lake based cage Aquaculture Park at the Mwena landing site.
- Undertake further study of the pond based Aquaculture Park at Apac particularly for the land tenure issues and pumping head requirement.
- Undertake further analysis of the community scale Aquaculture Park models

Recommended steps for implementation

The main steps in the planning, implementation, management and review process are outlined below;

Step 1 – Initiation and planning
Step 2 - Site identification and suitability assessment
Step 3 – Background studies and design
Step 4 – Infrastructure development and start-up
Step 5 - Co-management and coordination
Step 6 - Monitoring and control.
Step 7 – Evaluation review and feedback

Recommended further studies

There are a number of additional studies that it is recommended to undertake.

Site suitability study. There needs to be further site suitability studies on the proposed sites (Apac and Mwena) including topography, bathymetry, water quality, soil characteristics, land ownership, etc.

Carrying capacity study. There needs to be carrying capacity estimation undertaken for the identified Aquaculture Park zones using modelling to determine the maximum production the site can sustain.

National aquaculture scoping and zoning study. In order to determine how the Aquaculture Park concept can be replicated in Uganda, there is a need for a National aquaculture zone identification study using satellite image analysis, GIS and site selection criteria.

Long-term technical assistance. There is the need for long-term technical assistance for Aquaculture Park set up and training. A potential donor should be sought to fund this.

Strategic Environmental Assessment of cage culture in Lake Victoria. To establish the appropriate scale of cage farming Lake-wide. The SEA should analyse the policy and legislative framework, describe requirements for lake based fish farming systems, mitigation and monitoring.

Review of legislation and regulation framework with recommendations. The legislative requirements for aquaculture at the institutional, governance and administrative level are substantially different from those for fisheries and with development of the sector would warrant specific attention.

1 Introduction

Uganda has significant potential for development of a commercial aquaculture industry. It has fast growing fish species (Nile tilapia, African catfish); extensive freshwater resources suitable for cage, pond and tank based aquaculture systems; its agriculture and fisheries sector produces most of the raw materials needed for locally made fish feeds; the Ugandan population is used to eating fish; and it is strategically placed in the EAC Region for regional exports.

Large-scale cages in the Ugandan sector of Lake Victoria could easily support an industry producing 100,000 t/yr without any noticeable environmental impact if regulated and managed properly. Lake Albert also has potential for deployment of large cage systems, and many smaller water bodies including slow-flowing sections of rivers and reservoirs have potential for small-cage aquaculture.

Uganda has a highly developed fish processing sector which until now has been focused on the export of Nile perch products to Europe. Local and regional market potential is huge with growing populations and declining wild fish catches. A productive commercial aquaculture industry could supply a new source of high quality raw material for 'added value' products for these local, regional and international markets.

The development of commercial-scale fish farms in Uganda is supported by several Government policies and strategies, because of its potential role in generating incomes and employment and in contributing to food security, in particular:

- the National Fisheries Policy (2004);
- the MAAIF Development Strategy and Investment Plan (2010-2014);
- the Uganda National Aquaculture Development Strategy (2008); and
- Investment terms provided by the Uganda Investment Authority.

However, despite the policy intention and the obvious physical potential, there are few examples of profitable aquaculture businesses in Uganda. Perhaps the only thriving sector is hatcheries, producing catfish fingerlings for bait and tilapia and catfish fingerlings for stocking Ugandan, Rwandese and Kenyan fish farms. In the farming sector itself, small-scale producers have not been shown to be especially sustainable, and there is only one commercial farming operation of any significant size (the Source of Nile fish farm at Jinja). The lack of aquaculture development is in contrast to some other African countries, notably Egypt (with a production volume of close to 1 million tonnes in 2011), Nigeria, Zambia, and also Kenya which has shown significant growth in recent years, albeit from a low base.

A previous study completed (by Poseidon/Cowi) for the EU Delegation in 2011 examined the promotion of commercial aquaculture in Uganda. That study identified a number of key constraints and issues that constrain the development of the sector. In particular the study identified that:

- The current policy and 'cost' environment is not supportive of the sector at all stages of the value-chain; and
- There is a lack of sufficient emphasis on marketing (e.g. market segmentation, market infrastructure, price promotion, etc.), which ultimately constrains profitability.

In addressing the first constraint above, the study suggested that one potentially very important solution would be the development of 'Aquaculture Parks', which could be government-owned developments providing basic infrastructure for fish farmers, similar in concept to business parks. The study concluded that a future 'EU intervention would assist the Ugandan Government to improve access to suitable development areas for commercial aquaculture. The recommendation forms the principal background and justification for this project undertaken in November 2012 with the final report due in December 2012.

Objectives

The objectives for this project are clearly specified in the ToR and are as follows:
The overall objective will be to contribute to the development of fish farming in Uganda.

The specific objectives are:

- To propose the adaptation of APs concept into Uganda's context;
- To assess the suitability (design, cost and operating) of the Aquaculture Park concept in Uganda at two sites to be availed by the Ministry of Agriculture Animal Industry & Fisheries (MAAIF); and
- To assess the market for Uganda's aquaculture products at the National, Regional and International level.

Report structure

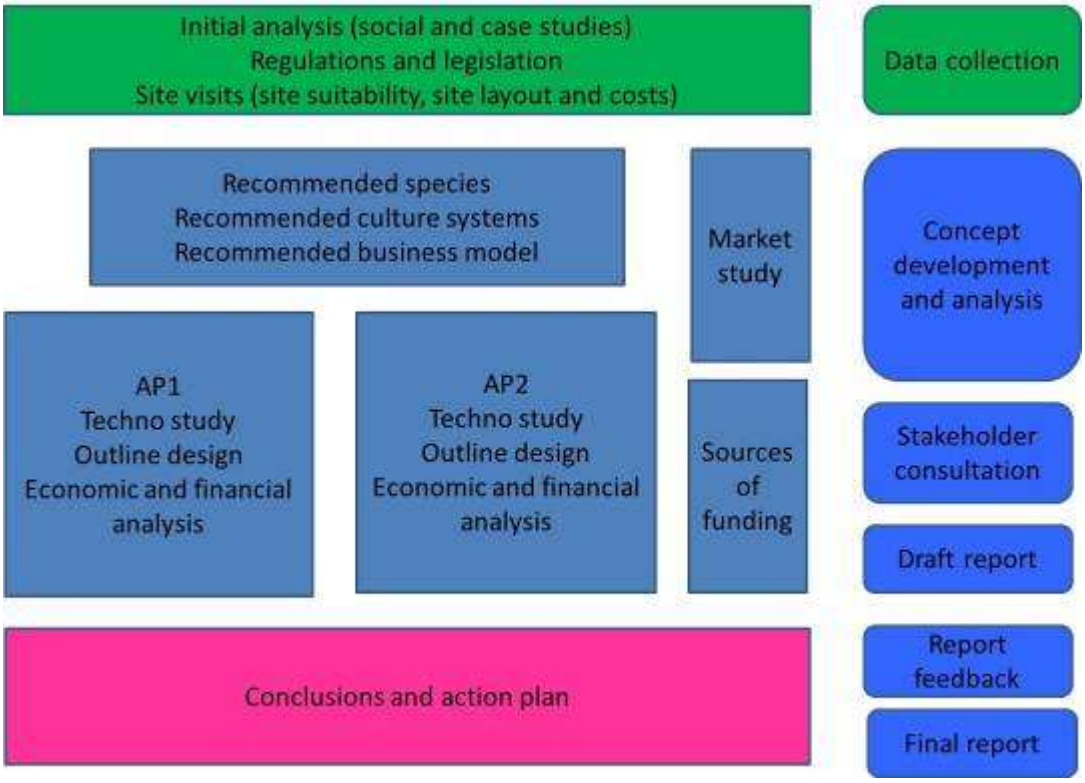
The report structure is outlined below, illustrating how each section addresses requirements in the ToR.

Report section	Cross reference to ToR
2 Approach and Methodology	
3 Aquaculture Park concept & case studies	a. describing the AP concept
4. Adaptation to Ugandan context	b. adapting the AP concept
5. Techno-economic feasibility	c. feasibility F. repayment of financing options
6. Outline design	d. outline design
7. Planning initiation & management	c. feasibility
8. Markets & Marketing	g. evaluation of markets
9 Funding options	e. funding options
10. Legislation & regulation	h. mitigating strategies j. regulatory requirements
11. Recommendations	Summary of the above

2 Approach & Methodology

The work of the team was guided by the Terms of Reference with an overall approach consisting of three phases: data collection, analysis & concept development and reporting. These are illustrated in Table 7 and described below.

Figure 4 Proposed methodology



Phase 1 – Data Collection

Data collection and stakeholder meetings

The first week of the project involved the team meeting with a wide range of stakeholders to get a better understanding of the local conditions. Meetings were held with:

- Fish farmers
- Fish processers
- Fish farm associations
- Cooperatives
- Government representatives (Central and District)

A full list of those consulted is presented in Annex 1.

Site visit and district consultations

During the second week, the project staff undertook site visit to the two selected sites to collect field data and to meet with District officers and local communities. This was essential for site evaluation and to collect local information. The National Fisheries Research Institute (NaFIRRI) conducted sampling of various soil and water parameters at these sites.

Note: At the time of writing the results of this sampling has not been provided to the assessment team.

A third site at Lira was also identified for consideration and so was visited during the Apac site field visit. Site visits were therefore conducted at:

- Apac close to Masindi Port
- Lira valley buffer dam rice irrigation scheme and valley tank site
- Mwena landing site on Bugala Island

In addition to site visits, meetings were held with district production and fisheries officers to appreciate the local context.

Phase 2 - Concept development and Analysis

Phase 2 of the study developed the appropriate Aquaculture Park concept for Uganda and analysed the technology, methodology and governance that will work in Uganda.

Concept development

The study considered Aquaculture Parks developed in other countries to learn lessons from the successes and failures. Analysis was made for:

- Lake/sea based cage farms (Philippines)
- Land based pond farms (Indonesia)
- Clusters of farmers (India, Vietnam)

The study also considered Ugandan case studies in development, management and funding to learn lessons from the successes and failures. Analysis was made for:

- Management (BMUs, fish farmer associations, cooperatives)
- Funding and credit (Sawlog, Agribusiness Trust)

Site selection and suitability analysis

The valley dam and valley tank sites in Lira were not further considered for Aquaculture Parks as they were reliant on seasonal water supply and could not offer the commercial scale of production required. They may however have potential as 'Community Aquaculture Parks', which is further explained in section 7.

The study undertook technical and economic analysis for the 2 different concepts on the proposed sites: a pond farm Aquaculture Park in Apac and a cage farm Aquaculture Park at Mwena, Bugala Island.

The concept and the draft techno-economic evaluation were then presented to stakeholders during a workshop to discuss the recommendations and issues and get their feed-back. The team then took those comments and suggestions into consideration and addressed remaining gaps.

In parallel to this there was analysis of funding options and local and regional markets.

Species and culture systems

This phase analysed the species to be cultured, the culture systems, the level of intensity and technology to be used. It was decided that the Aquaculture Park should be based on improved technology and methodology.

Technical and financial analysis

This phase analysed the expected production performance (growth rate, survival, FCR, etc.) and developed business models for the different scales of enterprise (small, medium and large) as well as an Aquaculture Park company managing the site and providing services for producers.

Outline layout design of Aquaculture Parks were prepared at the proposed sites.

Estimates were prepared for;

- capital cost
- operational cost
- profitability
- payback time

Business models were prepared for;

- Small scale producers
- Medium scale producers
- Large scale producers
- Aquaculture Park Company

Stakeholder Workshop

A half-day stakeholder workshop was held at NaFIRRI Aquaculture Research Station in Kajansi, where the initial findings were presented and stakeholders gave their feedback. There were 34 participants at the workshop that represented the principle parties with interest in the development of Aquaculture Parks in Uganda. This included representatives from the primary Ministries, cooperatives and associations and private sector. Six District Officers attended from the proposed sites. A summary of feedback from the stakeholder workshop is presented in Annex 5. These comments were considered in the development of this report.

Phase 3 – Conclusions, recommendations and action plan

The team then prepared the conclusions, recommendations and developed an action plan for implementation in the final report. This draft report is to be submitted to the EU and then will be distributed to participants of the stakeholder workshop and other key people for comments. The comments will then be addressed and the final report submitted before the end of the year.

3 AQUACULTURE PARK CONCEPT AND KEY ELEMENTS

Optimism about the potential benefits of Aquaculture Parks is not unfounded. Experience in other countries has shown their potential benefits and provides important lessons of potential relevance for their use in Uganda.

Clustering of aquaculture operations has developed in various forms around the world based on the different socio-economic and production needs. There are top down organisational clusters where a company, committee or agency organises and manages production from small scale producers, and there are bottom up organisational clusters where small scale producers agree to work together to manage themselves as a cluster.

There are a number of **benefits** ranging from these different models for clustering, which include:

Improved Planning and management of aquaculture development
Development in defined areas (e.g. safe aquaculture zones in Vietnam or Aquaculture Parks in the Philippines) should ensure it occurs in appropriate areas; minimise conflict with other resource users and ensure long term legal rights for production in those areas.

Encouragement for the development of small to medium aquaculture production businesses
In many countries aquaculture development starts at the corporate scale with large farm development set up by larger companies who dominate production. Typically the development of small to medium sized aquaculture enterprises by small local companies is more problematic, but nevertheless important given the potential for smaller operators to encourage remote development providing livelihoods, opportunities for diversification and employment for small communities. However, Aquaculture SME development requires the widespread transfer of appropriate technology, technical support and financial loan facilities to facilitate development. These factors can be better provided and focussed when small-scale producers cluster together.

Cost savings and economies of scale
Clustering encourages aquaculture support industries to become established the same area for example, hatcheries, cage construction, net cleaning, net mending, and marketing. This can generate cost savings in input activities, thereby reducing costs throughout the rest of the value chain. Clustering of farms also allows the use of shared infrastructure for example jetties for loading/unloading feed and fish, boat mooring areas, security etc., as well as shared management.

Economies of scale can also be generated for forms of service provision which the private sector may be unlikely to provide on its own, and which it may therefore be appropriate for the Government to provide. Given typical pressure on government budgets, reducing the cost for it to support the sector can be critically important.

Diversification into aquaculture by fishermen and rural communities
The need for fishermen to diversify is already evident in Lake Victoria with declining incomes and declining stocks. The promotion of diversification is a means to ease the transition to reduce fishing pressure on stocks and to provide fishing-dependent coastal and remote communities with new business and employment opportunities.

The choice of target beneficiaries and identification of diversification options to support livelihoods of fishing-dependent people typically depends on the main objectives and the orientation of wider economic development and environmental management policy. Typically, diversification in a fisheries context is promoted to achieve one or more of the following outcomes:

- economic opportunity and stability: improved incomes, diversification of business and earning opportunities and economic growth;
- reduced vulnerability: reduced risks of failure, buffer against seasonality, shocks and adverse trends – e.g. climate change; and
- reduced pressure on natural resources: reduced fishing effort, reduced demands of aquaculture on ecosystem services.

Evidence of successful diversification by fishermen into aquaculture is limited because there have been few long term systematic projects that have been well adapted to the needs of fishermen and adapted to their business model and financial and operational capabilities.

Guiding principles

There are a number of guiding principles that should be followed to achieve the responsible and sustainable development of Aquaculture Parks. These are the Code of Conduct for Responsible Fishers (CCRF) and the Convention on Biological Diversity, both are addressed by the Ecosystem Approach.

The Ecosystem Approach to Aquaculture (EAA) (FAO, 2010), and the Ecosystem Approach to Fisheries (EAF)(FAO Fisheries Department, 2003) have developed in response to the need to implement, in a practical manner, the principles of sustainable development (WCED, 1987), the Convention on Biological Diversity (CBD, 1992) and the Code of Conduct for Responsible Fisheries (FAO, 1995). EAA and EAF are consistent with all these principles and have been adopted by the FAO Committee on Fisheries (COFI) as the appropriate approach to implement these principles for the management of aquaculture and fisheries.

Ecosystem Approach to Aquaculture

EAA not only deals with all the ecological consequences of aquaculture, but it also explicitly deals with the social and economic implications (good and bad) generated by the management and institutional arrangements.

EA works by the identification and assessment of all relevant issues and the establishment of participatory processes to help address high priorities effectively and efficiently. It assists with making the best decisions with the information available by using a precautionary (to reflect the risk) and an adaptive approach (to improve knowledge and adjust decisions). Implementing EA helps to develop holistic management systems that seek the sustainable and equitable use of the whole system (ecological and human) to best meet the community's needs and values.

The Ecosystem Approach addresses both trans-boundary issues and scale issues.

- **Trans-boundary issues**. When the watershed boundaries go beyond political boundaries, different authorities (or, in some cases, even different countries) will need to be involved. The Lake management bodies' play an important role in this respect, as they can provide the political platform for the implementation of the EAA and EAF. Of particular significance for this project is the potential expansion of Lake Victoria Fisheries Organisation's (LVFO) remit to oversee aquaculture development in the lake (S.Babura pers. Comm.).

- **Scale issues**:
    - **local fisheries or farm scale**. The individual farm is often easy to locate and identify, and local effects are often easy to assess, although in cage aquaculture, especially in open ecosystems such as large lakes, it may be challenging to establish the boundary of potential effects. Most management practices are developed for this scale and most top-down regulation measures, such as the environmental impact assessment (EIA), worldwide apply at this scale.
    - **The watershed/waterbody/aquaculture zone regional fisheries**. This geographical scale includes a cluster of farms that or fisheries that share a common waterbody and that need a coordinated management.

Key elements

There are a number of key elements that need to be considered when developing an Aquaculture Park concept for a new country and environment. These include Design, Operation and funding.

- **Design**. Aquaculture parks have developed in a number of countries around the world and in each country the concept is slightly different as they have been adapted to the cultural, social and business conditions as well as environment, culture species and system in a particular country. In many cases the initial development of a concept design at the start is quite different from the successful business model that develops. Therefore the design of the first Aquaculture Parks in Uganda need to be a flexible design that can easily be adapted during operation to suit the social, cultural and business needs of Uganda. Once a successful aquaculture Park model has been developed, then it can be replicated around the country with minimal further changes to the design or concept.
- **Operation**. There are two aspects to the key elements to Aquaculture Park operation; operation of the first concept aquaculture park and operation for farmers new to aquaculture.
    - The operation of the first Aquaculture park needs strong technical support and guidance to develop and optimise the production technology and methodology for the fish production. Typically there may be a a number of different species cultured and the scale of production will be different for different farmers (small, medium and large-scale) each of which require slightly different technology and methodology to ensure a commercial success. The Government needs to provide this strong technical support to develop these different production models. For example, the Bureau of Fisheries and Aquatic Resources (BFAR) in the Philippines has developed a number of economic models and business plans that detail the different commercial production models that can adopted by farmers.
    - Aquaculture Parks have been successful in developing aquaculture in areas where aquaculture has not yet developed. This is because of the technical assistance and guidance that is given to farmers that are new to aquaculture. For example BFAR arranges training courses for new farmers in the Regional Fisheries Training Colleges for theoretical training in fish production and farm economics as well as operating a small demonstration farm on the Aquaculture Park to demonstrate and train new farmers on best practice. In many cases, Aquaculture Park Better Management Practices have been developed that should be followed by all operators in the Park.

- **Funding**. Typically funding for Aquaculture Park development is a mix of funding from Central and local government as well as from the private sector. At the start of Aquaculture Park development, funding is heavily supported by the government but as the concept becomes established, Government support is less and funding from the Private Sector. This mix of funding is typically as follows;
    - **Central Government.** Funding for site selection, carrying capacity estimation, park Environmental Impact Assessment/Statement, farmer training, Park market coordination, demonstration farm and financial support/loan for very small scale farmers. Provision or a grant or low cost loan for the land based facilities (hatchery/nursery, marketing area, net cleaning equipment, etc).
    - **Local Government.** Provision of the land site, upgrading of roads and power supply to the land site, jetty, emergency services and issuing of licences to farmers within the site
    - **Private sector.** Funding for the capital costs for the production system (cages, nets, boats) and operational costs (seed, feed, etc).

Aquaculture Park Business Models

Clusters or Aquaculture Parks tend to be defined by having strict management within defined geographical areas, but a number of different models are available:

Aquaculture Park concept (APs).

The concept of the Aquaculture Park is patterned upon the development of an industrial estate in the sea (or large lake), wherein aquaculture plots are leased to investors/aquaculture farmers and infrastructure (mooring systems, navigation lanes and docking areas), utilities (support facilities) and technical services are provided by the government or a private investor.

Defined areas are selected where small-scale farmers are encouraged to locate and where production and marketing is coordinated by an Aquaculture Park management committee.

It is an integrated business approach in aquaculture, which is promoted by the Government in partnership with the private and public sectors. The major goals are to ensure food security and create livelihood opportunities for coastal communities and increase aquaculture production in a controlled sustainable and responsible manner.

An example of Aquaculture Parks is the Mariculture Park concept in the Philippines. The Mariculture Parks create an enabling environment wherein aquaculture farmers can operate their farms securely, cost-effectively and sustainably with the integration of support systems vital to the success of investments, such as: training for farmers, support from service providers, accessible and available sources of inputs, markets, financing, facilities and infrastructure (hatcheries, ice plant and cold storage, pier, laboratories, transport facilities) and responsive governance. The industry support system extends throughout the whole supply value chain.

Enhancing Aquaculture Development

The park allows controlled aquaculture development in suitable areas where production is limited to the carrying capacity of the environment rather than haphazard development of aquaculture which results in difficult monitoring and control by the Government.

Two pioneer Mariculture Parks were developed in the early 2000's and these parks required sustained technical support to develop the correct business model for small and medium scale farmers and develop the appropriate level of infrastructure and services to support the farmers. Following the demonstration of the successful model, the Mariculture parks have been replicated throughout country. As of 2012, there were 50 Mariculture Parks under development or fully operational in the Philippines.

Governance and management

The Central Government provides a number of core services including site identification, site evaluation, carrying capacity estimation and seed money to establish the park. The also assist with the preparation of a programmatic EIA that is undertaken for the whole zone and covers the individual farmers. They also assist with regular environmental monitoring of the park. Technical, financial and management training is given to the farmers through the Regional Fisheries Training Centres.

Local Government provides improvement to local infrastructure and controls the licencing of operators within the park.

The park management committee is primarily made up of farmers but also other stakeholders and they self-manage the operation of the farm. The Management committee can enforce that only accredited feeds are used by the farmers to ensure reduced impact to the environment. The management committee control the sequential stocking of cages from hatcheries and nurseries and control sequential harvesting to ensure that there is a regular supply of fish going to market.

Private sector

The farmers invest in the production facilities (cages, and nets) as well as the operating costs of production. The farmers are free to sell their produce to any buyer. Fish traders come to the Mariculture Park marketing area to purchase fish. Feed supply companies set up outlet shops close to the jetty and sell feed to the individual farmers.

Overall the Mariculture Parks are found to create an enabling environment for small and medium scale farmers to produce in managed and supportive conditions and benefit from the economies of scale of a larger production unit. Nucleus estate concept.

Some countries have implemented aquaculture nucleus estate farms for the development of aquaculture (for example Indonesia where it is known as the nucleus pond estate "Tambak Inti Rakyat, TIR").

The nucleus of the estate farms are built in 200–300 ha blocks and consist of a common water supply system including the central pumping station; hatcheries for the production of seed stock; possibly a feed mill; processing, packing and marketing facilities as well as a corps of extension technicians which are operated by a developer. The "plasma" consist of the grow-out ponds with an average size of 0.5 ha which are to be distributed to individual growers who qualify under the program.

The small-scale farmers own pond areas and organised by farmer co-operatives, which are supported by a big owner or management company.

Specific benefits of the approach

The nucleus pond estate system has three main of benefits:

- **Rural development**. Planned rural development giving business and employment opportunities to a large number of local people
- **Appropriate technology**. Facilitating the introduction of modern aquaculture technology to a large number of farmers.
- **SME opportunities under the umbrella of a large production company**. It allows small scale producers to start production with a low initial investment cost and under the guidance of a larger company which has the benefit of passing on benefits of scale.

Key challenges to the approach

These schemes have not been especially successful, even though the concept is a good one, because of a lack of transparency by the "nucleus" in many cases on prices etc., preventing a real sense of partnership being developed.

There are a number of challenges to the nucleus estate approach that need to be addressed.

- **Insufficient technical guidance to farmers**. There have been a number of plasma/nucleus schemes that have failed due to the fact that private sector companies have failed to provide sufficient guidance to farms in their production areas and from whom they purchase product.
- **Lack of transparency.** In some Indonesian nucleus estate schemes, small-scale producers have protested against the unfair terms of their contracts with the managing company and the way the company's debts were being offloaded onto the small-scale farmers.

The nucleus pond estate system allows planned rural development giving business and employment opportunities to a large number of local people. It facilitates the introduction of modern aquaculture technology to a large number of farmers. It allows small scale producers to start production with a low initial investment cost and under the guidance of a larger company which has the benefit of passing on benefits of scale.

Farmer Cluster concept.

Farmer clusters are defined geographical areas where there is voluntary or enforced agreement between all the producers for the management of fish health, environmental impact and escapes. An example is the Indian Aqua farmer clubs.

The benefits from the clustering farmers in India are related to organizing farmers for a more effective adoption and the implementation of Better Management Practices (BMPs).

Organizational levels. There are three types of farmers' organizational units that were formed primarily to encourage the uptake of Better Management Practices (BMPs):

- **Cluster** - a group of farmers whose shrimp ponds are situated in a specific geographical area and their ponds depend on the same water source.
- **Aquaclub** - an informal group of farmers cooperating with each other on various aspects of management in the cluster. Farmers of more than one cluster can form an Aquaclub.
- **Society** - a formal and registered group of (20 to 75) farmers in a locality. The Societies are organized according to a model established by the government; registered with the Ministry of Revenue, and subject to annual audits by government officials to verify accounts and ensure a democratic and transparent management.

In India small-scale farmers were organized into self-help groups - the Aquaclubs. Technical staff, government extension and research personnel and regional managers developed the BMPs with participation of the farmers. The promotional work included seminars, field visits, demonstration, and the production of manuals and posters that were translated into local languages.

Two organizational issues are especially critical for success:

- leadership and capacity building of the club or association,
- ability of the farmers organizations to establish and maintain contractual relations with hatcheries, feed suppliers, processors/exporters and buyers.

Lessons learned

The following tables summarise some of the elements to be considered in developing Aquaculture Parks:

Abbreviation	Source
PMC	Philippine Mariculture Park
INC	Indonesian Nucleus Estate
IAC	Indian Aqua Club
VSAZ	Vietnamese Safe Aquaculture Zones

Planning

Lessons learned for Planning Aquaculture Parks

Lessons learned - Planning	**Source**
Site identification, site evaluation and suitable site selection based on agreed site selection criteria	PMP
Selected area is designated for aquaculture production over the long term.	PMP
Production carrying capacity estimation for the zone to set the maximum production level and ensure minimum environmental impact	PMP
Programmatic Environmental Impact Assessment for the whole zone that covers the individual farmers	PMP
Common facilities and infrastructure are developed (hatcheries, ice plant and cold storage, pier, laboratories, transport facilities)	PMP
The promotion of the private sector to develop and manage the Nucleus Estate	INE
Establishing physical or natural buffers between zones	VSAZ

Operation

Lessons learned for operating Aquaculture Parks

Lessons learned management	**Source**
A management committee is established to self-manage day to day operation	PMP
The Park has bye laws that farmers must abide to	PMP
All farmers are licensed and pay an annual fee to the local Government (to recover infrastructure costs)	PMP
Training is provided to new farmers (technical, financial and management), regular training is provided to all farmers	PMP
Controlled sequential stocking of cages from hatcheries and nurseries and controlled sequential harvesting	PMP
Organised bulk supply of feed	PMP
Regular environmental monitoring of the park.	PMP
The need for transparency in the management company especially in service charges, marketing prices and economic profitability of the estate management company	INE
The need for close cooperation and feeling of partnership between the farmers and the Park Management company	INE
The provision of seed and feed on loan to the farmers with repayment of the loan at harvest (contract growers).	INE
The benefits of clustering existing small-scale and medium-scale farmers into organisations for mutual benefit	IAC
The need for strong leadership and capacity building of the club or association,	IAC
the ability of the farmers organizations to establish and maintain contractual relations with hatcheries, feed suppliers, processors/exporters and buyers.	IAC
Improving farm productivity by controlling the quality of seed, feed quality, water quality and practices of integrated pond management.	VSAZ

Introduction of co-management with the participation of local farmers through the participatory approach to and co-management of the safe shrimp culture.	VSAZ
Good aquaculture practices for the hatchery supplier and farms within the zone	VSAZ
Good feeding practice	VSAZ
Lessons learned – technical support	
The need for strong technical guidance to farmers so that they can optimise production	INE
The benefits of developing Better Management Practices between government extension and research personnel and farmers	IAC
The promotional work needed to promote BMPs including seminars, field visits, demonstration, and the production of manuals and posters that were translated into local languages.	IAC
The benefits of implementing Better Management Practices to improve productivity and profitability	IAC
The targeting of the groups of farmers by government extension and research personnel	IAC
Lessons learned - Biosecurity	
Fallowing production facilities to break the disease cycle	VSAZ
Controlling of risks (water supply, seed health status, utilization of chemicals and antibiotics) to shrimp quality and food safety.	VSAZ
Good biosecurity measures taken by the hatchery supplier and farms within the zone	VSAZ
Responsible use of drugs and chemicals that are not banned	VSAZ

Ugandan models

There are a number of lessons to be learned from the analysis of experiences in Uganda (both within the fisheries sector and outside it) to help determine what has worked well and what should be incorporated into the Ugandan concept (and what should be avoided).

Source of Nile

The Source of Nile Limited (SoN) was started in 2005 by Lake Harvest and Ugandan investors and is now the largest fish farm in Uganda producing around 400t/year. Its products are table sized tilapia for sale to regional traders and fry for sale to other fish farmers. The farm plans to expand its production further off-shore using larger cages. Key lessons learned from SoN are associated with the value of establishing mutual functional relationships with the local communities, notably:

- SON relationship with the local Beach Management Unit (BMU) has resulted in the reduction of cage theft, enabled the company to source and vet local labour. As a result, there is a sense of co-ownership with both parties protecting each other's interests. Adult children of BMU members are trained and given jobs caring for fish on the farm, fishermen within BMU permitted to fish within specified areas of the cage farm. Thefts have reduced and if they do occur, the BMU has been actively involved in identifying and finding culprits.
- The proposed expansion into larger cages is likely to reduce the number of small cages used by the farm for table fish. This opens up the opportunity for leasing the un-utilized facilities to medium and small-holder operators under the supervision of SON to ensure sustainable management (notably, for water quality management and disease control) as well as fish quality control. Such operators are likely to have access to the markets established by SON, as potential out-growers, etc. (Patrick Blow, pers comm.).

BMUs

Beach Management Units (BMUs) are a key component of the country's fishery Community-Based Resource Management. Community-based co-management of the fishery is a system in which fishers, processors and the communities in which they live and work, all have a role to play in the management of the resource. Thus the BMU is comprised of the actors in the local fishery value-chain to whom authority is delegated by the relevant government institutions to run and manage the resource sustainably under given ordinances as the primary users of the resource.

The key principles upon which BMU's operate include community involvement, accountability, appropriateness, consensus, sustainability, fair and equitable resource sharing, information, communication , education, co-financing by members. Lessons learned:

- The sustainable use of common resources is in everyone's interest. Therefore it is important that all stakeholders are in agreement and jointly work upon agreed upon activities that promote the food health of the natural resources.
- The structure of the BMU's permits arbitration and conflict resolution.
- Good information, education, accountability and transparency are essential in building good will community.
- In several cases, information about specific areas may be limited for potential farmers. BMU's have a wealth of information based on their experience in the area that can be useful in site selection, mitigating against conflict, community issues, etc

WAIFCOS association

Walimi Fish Farmers Cooperative Society (WAFICOS) is a legally registered fish farmers' co-operative under the Uganda Co-operative Alliance (UCA). It was set up in 2004 primarily to provide a forum through which fish farmers could collectively acquire the essential services and inputs necessary to ascertain the viability of their fish farming operations. Accessing quality services is one of the major challenges for fish farmers in Uganda that has significantly limited the success of fish farming enterprises. Thus, among the essential services WAFICOS endeavours to make accessible to its members are technical advisory services, inputs, collective marketing, information dissemination and value addition of farmed fish products.

- An Aquaculture Park could be owned and/or managed as a whole or in part by farmers and other service providers on the park as a cooperative.

Uganda Cooperative Alliance

Uganda Cooperative Alliance (UCA) (www.uca.co.ug) Ltd was formed in 1961 by the Co-operative unions to act as the apex body of the cooperative movement in Uganda. UCA is one of the major pillars in cooperative operations and economic development in Uganda. Its roles include advising, regulating, re-organizing, and revamping the numerous cooperatives in the country as well as lobbying and advocacy. UCA's core values are (i) Honesty, (ii) Dedication (iii) Transparency (iv) Integrity, which are essential for good business. Its key activities are:

- Capacity building in primary societies and Area Cooperative Enterprises. Several of the cooperatives in the country are based on commodities, e.g. WAFICOS.
- Establishing financial systems based on members own savings, (i.e. savings and credit cooperatives, SACCO's).
- Technology transfer to raise productivity and income by small-scale producers
- Women empowerment in development
- Creation of self-employment by the youth and Environmental protection and improvement

Main lessons Learned:

- Individual co-operatives can benefit from the wider support structure provided by UCA.
- Small and medium scale operators can form SACCO's, from which they can borrow at interest rates lower than commercial banks to finance part of their operational costs.

4 Adaptation of the Aquaculture Parks concept to Ugandan situation.

Aquaculture Parks (APs) developed abroad need to be adapted for the Ugandan situation and these adaptations are identified below.

Principles and guidelines

There should be some key principles and guidelines that should be considered and followed in development of an Aquaculture Park development strategy. Recognising the current barriers to development of the sector, the Ugandan APs should be guided by the following principles.

Transparency

Transparency, as used in a business context more generally, implies openness, communication, and accountability. Transparency is operating in such a way that it is easy for others to see what activities are undertaken, the economics of the enterprise and the decision making process. Transparency can contribute to legitimacy and acceptance of decisions and therefore compliance.

There should be full transparency of the APs actions, which is facilitated by adopting a company approach (ownership & accounting transparency) and establishing a Management Committee of AP producers to steer company actions.

Co-management or self-management

Co-management has been advocated strongly in the Fisheries sector. It is an evolving process of partnership and power sharing between the authorities in charge, fishers/farmers and other shareholders. It allows self-management to ensure mutual benefit for all the participants and a feeling of ownership of the Project.

Co-management by farmers is an appropriate approach for improvement of management practices of the aquaculture area; it would help reduce risks in terms of diseases and environmental impacts.

Farmers should be the majority in the Management committee.

Adaptive management

Adaptive management has emerged as the most appropriate approach for ecosystem management as it considers that the whole system, with interlinked social and ecological components is constantly changing and presenting surprises. Adaptive management is a learning process approach to development which is characterized by the willingness to embrace error, to learn by doing, and to adapt. It is an iterative process of taking actions, evaluating the consequences of the actions, and adjusting future actions in light of changed conditions.

Adaptive management is based on a learning process, it improves long-term management outcomes. The challenge in using the adaptive management approach lies in finding the correct balance between gaining knowledge to improve management in the future and achieving the best short - term outcome based on current knowledge.

The management committee should apply adaptive management and governance as park develops to promote optimisation of production. Adaptation of the Aquaculture Park concept is expected due to local conditions and environment.

Towards gender equality

Women are more involved in the various aspects aquaculture compared to the traditional fisheries (Table 1). Being a fairly new sector, aquaculture has less traditionally defined roles based on gender compared to the fisheries.

Traditionally women have been housewives and men as bread winners. With modernization and education, there has been attitude change with several shared responsibilities across genders and equality in reward for labour. With more professionalism in the fisheries and aquaculture, more women are getting access to participate in these value chains. . Capability and interest as well as a person's access to resources for investment govern who does what in aquaculture. However, farm owners and managers have observed that female employees perform better in hatcheries with greater attention to detail compared to their male counterparts.

To attract and retain female employees, farmers endeavour to create favourable conditions notably; providing ablution facilities, safe farm environment both for female employees and their young children (in Uganda most young mothers working in a local community, particularly semi-skilled and unskilled, will go to work with their infants), pay salaries based on the assigned task and for those in remote areas, secure decent basic accommodation for personnel from outside the area.

Table 1 Gender issues in Aquaculture and Fisheries

	Aquaculture	**Fisheries**

Activity Profile ***(Who Does What?)***	• **Ownership:** Women are also owners and in several cases the operators of family farms.
	• **Jobs:** Both men and women are involved in professional and non-professional aspects in all aspects along the value chain.
	• **In production:**
	  • Pond/Cage Construction: Done by men
	  • Pond preparation and stocking: Done majorly by men but women are also involved.
	  • Management: Feeding and sampling done by women and men. More women are employed (as managers and unskilled labour) managers to in hatcheries because of their ability to pay greater attention to detail
	  • Harvesting: Ponds and cages is mostly carried out by men.
	  • Post-harvest Processing and marketing of farmed fish: Largely women owned enterprises.
	  • **Marketing:** Mostly done by
		• **Capture:** Fish capture is done by male fishers. Women only help in preparation of harvesting gear and bait at the landing sites.
		• **Processing:** Industrial processing is done both men and women. Artisanal processing of domestic market fish at the landing sites is carried out by women. This also involves processing of by products from fish factories like salting and drying fish skins.
		• **Enforcement and Quality control**: There are a substantial number of professional women in the sector. These act as fisheries officers for law enforcement and those working in quality control laboratories.
		• **Marketing:** Marketing of high quality products for exports and domestic affluent markets like fillets and loins is mostly done by men. Women as retailers mostly market low value/quality fish from lakes in markets. Fish transportation is a men's job. Mobile marketing of fish is also

	men but a few women are getting involved.	done by men as it involves riding and driving pickup trucks, motor cycles and bicycles.
Access and Control Profile ***(Who has What?)***	The patrilineal nature of Ugandan tribes has always favoured men on access of land and education. These later determine income levels and ability to invest in aquaculture or fisheries either at subsistence or commercial level. Therefore women have always been relegated to processing and marketing. However, the trend is changing with the education of a girl child. More women are now engaging in professional services and resource acquisition needed for fisheries and aquaculture. The more the women get involved the more the traditional gender beliefs in fisheries are challenged.	

Source: FAO/NORAD, 2012. Faces of women in global fishery value chains: Female involvement, impact and importance in the fisheries of developed and developing countries. Value Chain Small-Scale Fisheries Project, *unpublished*.

The availability and use of good quality feed

The quality of feed affects the performance of aquaculture production enterprises because feed typically comprises 60-70% of operational costs. In addition, the feed quality affects production limits due to the effect of feed on water quality and the nutritional status and growth of the fish. Thus if fish are to be raised at high densities profitably, a high quality feed is required that provides the fish all their nutritional requirements efficiently (i.e. with a low Food Conversion Ratio) without polluting the water.

Complete extruded commercial diets are produced in the country by Ugachick Poultry Breeders Limited. However, a number of farmers in the country still do not access/use this feed largely because of the relatively high cost of the feed, impacting profitability. Most Ugandan farmers therefore opt for on-farm feeds. Farmers also raise issues of variable quality (including excessive sand content due to beach-dried mukene fish meal inputs and the general supply of feed .

To produce the original set target of production from the two sites proposed in the TORs (see Annex 8) would require about 20,000 tons of quality feed per annum for table fish production. Ugachick's plant has the capacity to produce at most 5 tons per hour. It is not practically possible to achieve production levels for the required feed (Nakimu, pers comm.) and so additional capacity would soon be required. Currently production levels are about 5,000 tons/annum of extruded pellets. Of this, more than 50% is exported to regional markets in Kenya and Rwanda. Kenya ordered about 5,000 tons of feed from Uganda during its aquaculture stimulus campaign between 2010/2011.

Ugachick only produces grow-out feed for fish in nursery stage to table size. Its fish feed products are 35% CP, 30% CP and 25% CP that are produced as 5-mm and 3-mm pellets or powder (siftings from respective pellets). The small catfish hatcheries up country depend on farm produced feed for the larval and early juvenile stages after which fish are reared in fertilised ponds fed with 35% CP Ugachick pellets or farm-produced feeds (this included adding more fish meal to 35% CP Ugachick powder).

Ugachick's plant has the capacity to produce 45% CP diets pending the installation of a fat sprayer. However, due to the current low demand for hatchery feed (i.e. relative to Ugachicks current infra-structure) it does not yet make economic sense for Ugachick to complete its investment in this line. The +45% CP primarily target Catfish hatcheries whose current production levels are estimated at less than 1,000,000 fingerlings per annum. This level of production assuming FCRs of not more than 1 to produce a 5 g translates into a feed demand of 5 tons per annum.

A few hatchery producers buy hatchery feed from Ranaan in Israel through a local agent. The import-ed feed is air-freighted as requirements would not fill a 40ft container, making it difficult for the man-ufacturer to ship regular consignments from the factory to Uganda, hence the relatively high cost (US $10 per kg compared to US $1.6 at source).

It is proposed that the Aquaculture Parks use extruded floating feeds that are initially imported (at a scale resulting in much lower prices and this enables containerised transport rather than airfreight) until local fish feed supplies are improved and cheaper. The guaranteed level of demand from Aqua-culture Parks will readily translate into increased production and will attract additional investment into feed manufacturing.

The availability and use of good quality seed

Stock quality refers to a variety of factors notably the genetic make-up, general health, physical and physiological characteristics of the fish. Poor quality stock results in poor performance regardless of other factors. Much of the brood-stock used by hatcheries to produce fry and fingerlings is unselected. In addition, fry and fingerlings of both catfish and tilapia are produced under a wide range of management conditions by the different hatcheries.

Thus due to the lack of production standards for hatcheries, there are wide variations in stock quality, including simple things like having mixed species in the batch. Only one farm produces selected single sex tilapia, all others are mixed sex. Survival and growth rates on out-grower farms are consequently affected. By the early 2000s, 41% of farmers obtained tilapia fry from hatcheries, 11% from other farmers and 48% from the wild (Sarnissa, 2008).

For large commercial enterprises, seed quality is a key constraint as the performance of the enterprises depends on its efficiency, reliability and turnover. It is proposed that a hatchery and nursery is integrated into the Aquaculture Park to allow good quality control and prevent the introduction of disease.

For the past two years, more than 60% of tilapia fingerling production from the major hatcheries (which produce to order) was exported to regional markets of Kenya and Rwanda where there were government programmes promoting the development of aquaculture that included seed as part of farmers starter pack. A total of 64,000,000 tilapia fingerlings were required for the Kenyan farmers and most of this was supplied from Uganda (Susan Njeri, pers comm.). It is also easier to produce tilapia fingerlings as the production is pond based with fertilisation, the Ugachick fish feeds suffice. Furthermore, the cost of feed has resulted in more of the smallholder fish farmers shifting to tilapia production with catfish for predator control; a system that can easily be managed with fertilisation and supplementary feeds. Ugandan demand for catfish fingerlings (for production and as bait in fisheries) has also dropped. The regional demand for tilapia fingerlings and the reduced catfish demand has resulted in most hatcheries (including those that were set up to produce catfish fingerlings) shifting to tilapia fingerling production from mostly catfish fingerlings up to 2009.

For large commercial enterprises, this provides a challenge because the performance of the enterprises depends on their efficiency, reliability and turnover. Hence, though it is possible to get the required numbers with some effort, It it is proposed that a hatchery and nursery is integrated into the Aqua-Park to allow good quality control, and prevent the introduction of disease and ensure supply is synchronised to the production needs of the park.

Continuous technical support and guidance

Setting up and operating the Aquaculture Parks requires the support of an experienced technical team. With reference to production, there are at least three tertiary institutions offering tertiary training in aquaculture in Uganda, namely Fisheries Training Institute, Makerere University and Busoga University. However, the trainees from these institutions lack the practical skills in large-scale intensive commercial aquaculture as most Ugandan farmers are smallholders. It is easier to source skilled personnel in marketing and for fish processing locally. However, technical expertise in handling such volumes of fish for the local and regional markets is yet to be developed.

Extensive Technical Assistance will be required during the establishment of the first Aquaculture Park(s) and this is expected to come from overseas where there has been practical experience of successful AP establishment. Training will be undertaken by having a full time aquaculture technician who will train all new farmers and provide continual technical support. In addition, farmers will be required to follow Good Aquaculture Practices.

Culture Species

The local species that currently offer the best potential for large commercial culture l are the Nile tilapia (*Oreochromis niloticus*) and the African catfish (*Clarias gariepinus*). The production techniques for these species are well established (although it is proposed that performance be improved under AP guidance). As they are Uganda's main culture species, there is evidence of their performance under local conditions. In addition, both species are marketable both locally and within the region.

In the future other species such as Labeo and Nile Perch may be cultured among others, as commercial-scale culture is developed.

Site suitability

Site description and suitability (cage site)

The technical suitability of a site for Aquaculture Park establishment draws from the suitability of any given site for aquaculture production activities in general. The determining parameters for suitability vary depending on whether the intended aquaculture production facility is land based (ponds) or water based (cages). The Lake Victoria site, having been proposed for a water based Aquaculture Park, draws this study to determine the suitability of the Lake Victoria waters in the vicinity of Bugala Islands for Aquaculture Park establishment.

Key suitability parameters of water bodies for cage aquaculture (or cage culture) production operations include;

- Sufficient water column depth, to allow wastes and left over food to settle and decompose at safe distance without causing competition for oxygen between the cultured fish and the decomposition bacteria. The water column also serves as a guard against disease transfer from the decomposing substances to the fish. A cage depth to water column depth ratio of 1:3 is ideal.
- A water current flow rate that will effectively wash fish wastes and un-eaten food through and out of the cage at a rate such as to constantly maintain the optimum water quality balance for best production results. A water current flow rate of 1 to 6 meters per minute is usually effective in delivering optimum production results.
- A consistent supply of naturally occurring dissolved oxygen at such concentration levels as to support the high fish densities that are characteristic of cage culture. 5mg of dissolved oxygen per litre of water and above, at water temperatures between 28 – 30^{o}C is ideal.
- A relatively low micro-organism population, to a secchi disc reading of between 80 – 200 cm, as this will ensure a biomass balance in favour of the cage farming activities, when keeping environmental impact in check.
- Alkalinity and hardness above 20 in order to keep the water pH within safe range for fish life sustainability.

In addition to the general requirements for water based aquaculture establishment, an Aquaculture Park, being a large commercial entity has to additionally consider;

- Close proximity to land that is suitably profiled for
    - ✓ Fish landing
    - ✓ Construction of support facilities such as a hatchery and / or nursery, feed store, net making and mending workshop among others.
- A marketing outlet complete with one or more quality maintenance and preservation infrastructure such as an ice machine, a cold room and live fish handling facility.
- Access to industry support infrastructure, mainly electricity and good transport network.

Site suitability (pond site)

This site was proposed for study as a potential land based Aquaculture Park site. To this effect, the river is intended to act as a water source being tapped for supply to the ponds either by gravity or by pumping. If it is by gravity, the water is tapped from a location further upstream that is situated at a higher elevation through a diversion canal or a bulk water transfer pipe system to a reservoir. If the water is to be pumped, the pumping location should be within close vicinity of the reservoir so that the head to which the water is raised is kept to a minimum in favour of limiting operational costs so as to maximize the profits.

As such, the study of this site involved an assessment of the river and surrounding land in search for the location with the best suited match between river and land attributes such as to offer the most optimum Aquaculture Park productivity potential in the area. The key parameters of study, as is characteristic of feasibility studies for land based aquaculture include the following;

- **Water source characteristics and abstraction possibilities**
  A water source for a commercial aquaculture enterprise should have
  - ✓ A stable all year round flow rate for continuous productivity.
  - ✓ The ability to deliver at least 3 times the static water volume of the total pond area, for every production cycle. Aquaculture farm sizing, no matter how vast the availability of land may be, will always be subject to the amount of water available.
    A dissolved oxygen concentration that can sustain a population of at least 10tons per hectare for tilapia or 20 tons per hectare of catfish.

- **Land topography**
  Ideal land for aquaculture should have as gentle a slope as possible, just enough to enable water to flow by gravity through the production system. The gentler the slope, the more ponds one can establish on a given area because there is less space lost to steep slopes. In addition, steep slopes lead to soil erosion which degrades the ponds leading to frequent pond repairs, a negative impact on revenues.

- **Soils**
  Soils should be neither too coarse nor too fine. A blend of the two that has good cohesion characteristics when molded into a ball would be the best option. It should also have a high level of impermeability when compacted. The soils should also be of low organic matter so as to limit loss of oxygen to decomposition and avoid water loss due to seepage as created by the voids left in the pond dykes when organic matter decomposes.

- **Infrastructure characteristics (Roads, electricity, market proximity)**
  Aquaculture Parks should offer the advantage of availing quick and easy access to good roads, electricity and combined / communal marketing power preferably within the Aquaculture Park to reduce post-harvest handling frequency as this affects the quality of the product that gets to the end user.

Social and cultural aspects

The socio-economic benefits that are likely to be derived from the establishment of Aquaculture Parks are:

1. A significant increase in farmed fish production.
2. Production units that achieve economies of scale from facilities have the ability to provide gainful employment to both owners and employees.
3. Rural development. The Aquaculture Parks will result in the concentrated population who will require additional services such as accommodation for families, schools, etc. leading to the development of towns.
4. Promotion of commercial aquaculture in the vicinity of the parks and across the country.
5. Increased demand for commercial feeds in the country which will stimulate more investment in feed production and is likely to result in improved quality of feed produced.
6. Open up new markets and improved market access for farmed fish on the whole both locally and regionally because the volumes produced. The general population will become more familiar with farmed fish produces which will make it easier for even smallholder to sell their products.

Regulatory Requirements

The following is a summary of the regulatory requirements that would apply to the facilities:

Table 2 Summary of laws and policies relevant to aquaculture

National Laws, Policies and Guide-lines	Objectives
The Fisheries Policy, 2004 and The Fish (Aquaculture Rules), 2003.	- Ensure sustainable exploitation and culture of the fishery resources at the highest possible levels, thereby maintaining fish availability for both present and future generations without degrading the environment'. - To increase the quality and quantity of aquaculture-based fish production. -To ensure and increase the production of a diversified range of fish products including finfish and crustaceans. - To enhance fish production in minor lakes and reservoirs.
The Water Act, 1995 and 1998; Water Resources Management, 1995.	-Prevention of water contamination due to poorly handled waste -Prevention of discharge of wastes directly or indirectly into water -prevention of water pollution
The Environmental Impact Assessment Regulations, 1998	-All large aquaculture projects should submit an EIA report.
The National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations, 1999	-Provides for maximum permissible limits of 54 regulated contaminants which must not exceed before effluent to be discharged into water or land. In case of aquaculture most notable contaminants include are nitrogen, phosphorus, and suspended solids.
The National Environment (Waste Management) Regulations, 1999.	-Describes the sorting and disposal of domestic waste and provides that generator of domestic waste may without a license issued these regulations, dispose non-hazardous waste. -Propose adoption of cleaner production technologies to ensure that was is minimised.
The National Environment (Wetlands, River Banks and Lake Shores Management) Regulation, 2001	-Ensure that all wetlands maintain their ecological functions -Provides for provisions of permits for any activity to be undertaken in a wetland -Ensure that all impact studies are undertaken prior to utilisation of wetland systems.
Wildlife Management, 1996	-Promote conservation and sustainable utilisation of wildlife throughout Uganda so that the abundance and diversity of species are maintained at optimum levels commensurate with other forms of land use -Emphasis on public participation in wildlife management
The Land Act, 2004; National Land Policy, Land Sector Strategic Plan, 2000.	- Uganda's land resources productively and sustainably for security of livelihoods and poverty eradication. - systematic framework for addressing issues such as land ownership, distribution, utilization, management and control and the role of land in national development.

Table 3 Specific regulatory requirements for Aquaculture Parks

	Mweena	Apac
Fish Farming	Aquaculture Establishment Permit (Site to be designated by GPS readings). Seed Production Permit Fish Transfer Permit	Aquaculture Establishment Permit Seed Production Permit Fish Transfer Permit
Land	Land based structure are on government land. Since it is a government facility designated for fisheries marketing, there are no encumbrances. Building permits for the construction of additional structures from the local government.	Family owned land. Local inhabitants will have to be compensated if they are made to move to pave way for the construction of the aquaculture park. Land title for the aquaculture park Planning and building permits from permission from local government.
Water	No obstruction of water ways Water abstraction permit Effluent discharge permit	Drilling permits Water abstraction permit Effluent discharge permit
Environment	Certificate of Approval of Environment Impact Assessment.	Certificate of Approval of Environment Impact Assessment

5 Cage-based Aquaculture Park Technical and economic feasibility

Site location: Lake Victoria near Bugala Island

For the cage-based system, a number of potential sites in Bugala Island were surveyed by NaFIRRI with the recommendation that a landing site near Kalangala, called Mwena and the associated infrastructure (see images below) be chosen for consideration in the technical and economic feasibility study.

Figure 5 Location of Bugala Island potential Aquaculture Park site

Sites surveyed by NaFIRRI

Mwena, Bugala Island, Lake Victoria

Panorama view of the Mwena Landing site and bay near Kalangala

Flake ice machines and ice store

Marketing area

	
Fish landing jetty	Administration and meeting/training room

Recommended culture system

Tilapia is the selected species for cage culture because it has been shown that with the production techniques in use, one can guarantee both the volume and quality of yield. Catfish in cages on the other hand results in a wide variation in fish size at harvest.

The selection criteria for the culture systems was based on the natural resources available (lake or land), production capacity (i.e. tonnage), rates of return and a target minimum income level of USh. 1,000,000/= only per month for smallholders.

The cage culture system is specifically set to fit the Mwena landing site. Thus due to the limited amount of land of about 2 acres, the land available for the hatchery is about an acre (see Figure 8.) It is therefore recommended that the hatchery be a tank-cage system comprising the following: brood-stock holding hapa, spawning hapas, jars and tanks for incubating, hatching and early rearing through SRT treatment to 0.02-1g and stocking in nursery cages from 1 -15. The proposed set up is illustrated in figure Figure 9.

The grow-out section shall be run by small, medium and one large-scale operators. The small and medium scale farmers shall rear table fish using low volume, high density (LVHD) cages that have the capacity to produce up to 150 kg fish/m^3 of water. These units can easily be constructed locally out of a range of materials but will depend on the use of high quality floating feeds. Rearing fish in small LVHD is highly dependent upon the efficiency with which water can be completely exchange across the cage, washing out the wastes to maintain water quality. Such cages can be set closer to shore.

The large-scale operator (s) on the other hand shall produce fish in high volume low density (HVLD) cages set further of shore. These cages are more costly and will need to be imported. Table 4 below specifies the cage production options along with their key parameters.

Table 4 Cage production Options

Key Parameters	Input Levels		
	Small-holder	**Medium Scale**	**Large Scale**
Size of Cage (m^3)	2.5 x 2.5 x 2.5	4 x 2 x 3	12 m-D x 10 m deep
System	LVHD	LVHD	HVLD
Carrying Capacity	150 – 200 kg/m^3	150 - 200 kg/m^3	12.5 kg/m^3
Water Quality management	Water depth +6m	water depth + 10m	Water depth +25 m
	Net depth 3m	Net depth 3 m	Net depth 10 m
	Current 1 – 10 m/min (Optimum 5 m/min)	Current + 5 m/min	Current + 5 m/min (
	Water transparency + 1 m	Water depth + 1.5 m	Water transparency + 2 m
Feed	High quality extruded, min 30% CP, 5 kg/ha	High quality extruded, min 30% CP, 5 kg/ha	High quality extruded, min 30% CP, 5-7 Kg/ha
Yield	800 - 1000 kg/per cage	3,600 kg/per cage	12 to 15 tons/cage

Proposed number and sizes of cages

Nursery cages

300 Small cages

- 2.5 x 2.5 x 2.5 m deep

Stocked at 0.1 g and grown to 1 g

Small HDLV cages

300 Small cages

- 2.5 x 2.5 x 2.5 m deep
- Producing 800 kg/cage/cycle

Medium HDLV cages

300 medium cages

- 2.0 x 4.0 x 3 m deep
- Producing 1,200 kg/cage/cycle

Large LDHV cages

72 large cages

- Diameter 12 m x 10 m deep
- Producing 15 tonnes/cage/cycle

Site description

The proposed site was observed as having some suitable areas and the identified areas zoned in accordance with recommended Aquaculture Park design. The fish landing site at Mwena Bay, (Mwena A) that was rehabilitated and brought to international landing site standards under an ADB fund. The site, which has since its establishment been unutilized following the voluntary relocation of the local fishermen to another landing site close by (Mwena B), was found to have a number of infrastructure elements that could be used for the Aquaculture Park. In addition, the site is within close proximity of the ferry landing from Entebbe, one of two major points of exit from the Island to the main land. The other ferry landing located in Bukakata that hosts a ferry operating between the Island and Masaka district is 32km away from the Mwena A site. None the less, the road network on the Island is relatively good given the existence of an oil palm growing and refining industry.

Cage sizes of:

1) 2.5m long x 2.5m wide x 2.5m deep (small holder cages)
2) 4m long x 2m wide x 2.5m deep (Medium scale cages)
3) 12m diameter by 10m deep (Large cages)

were mapped (both in Mwena A and B) in groups of 600 small, 600 medium and 72 large cages in water depths of 8 – 10 metres, 10 – 16 metres and 30m and above respectively.

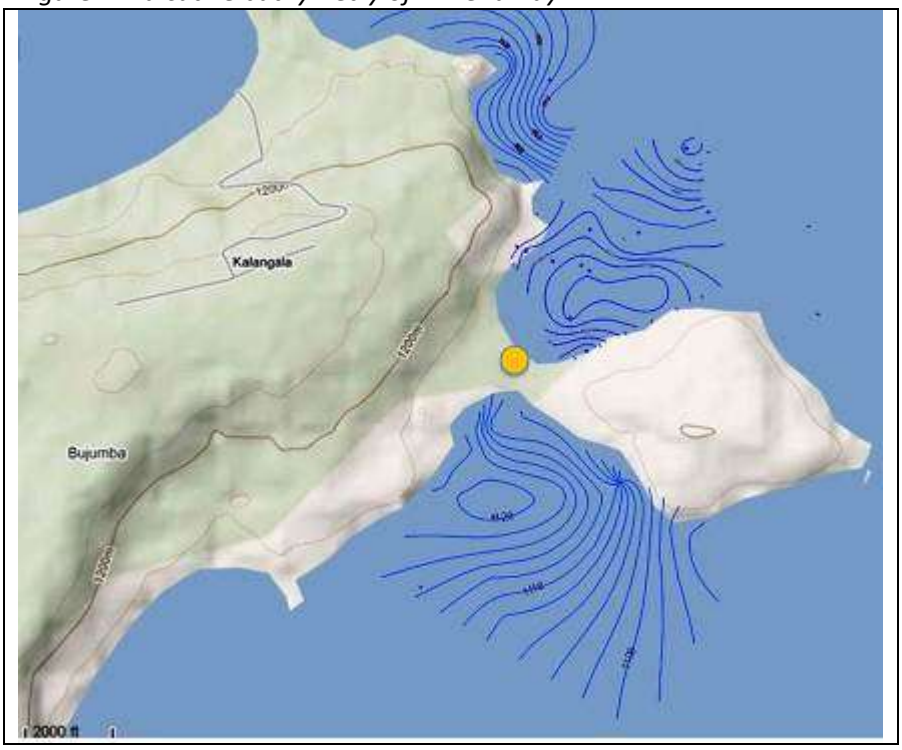
Some water parameters were sampled and found to be suitable for cage culture. However the team await further detail from the NaFIRRI sampling undertaken and would advocate additional sampling to better determine water movement in the area. See table of averaged results below.

Table 5: Site environmental data parameters.

Parameter	Site Average	Ideal
Water Current Flow Rate	67 revolutions in 30 seconds	1 – 6 meters per minute
Dissolved Oxygen	Not recorded	$\geq$ 5mg / Litre of water
Secchi Disc Reading	117.9 cm (Mwena A) and 136.2 cm (Mwena B)	80 – 200cm
Alkalinity	40 - 80	$\geq$ 20

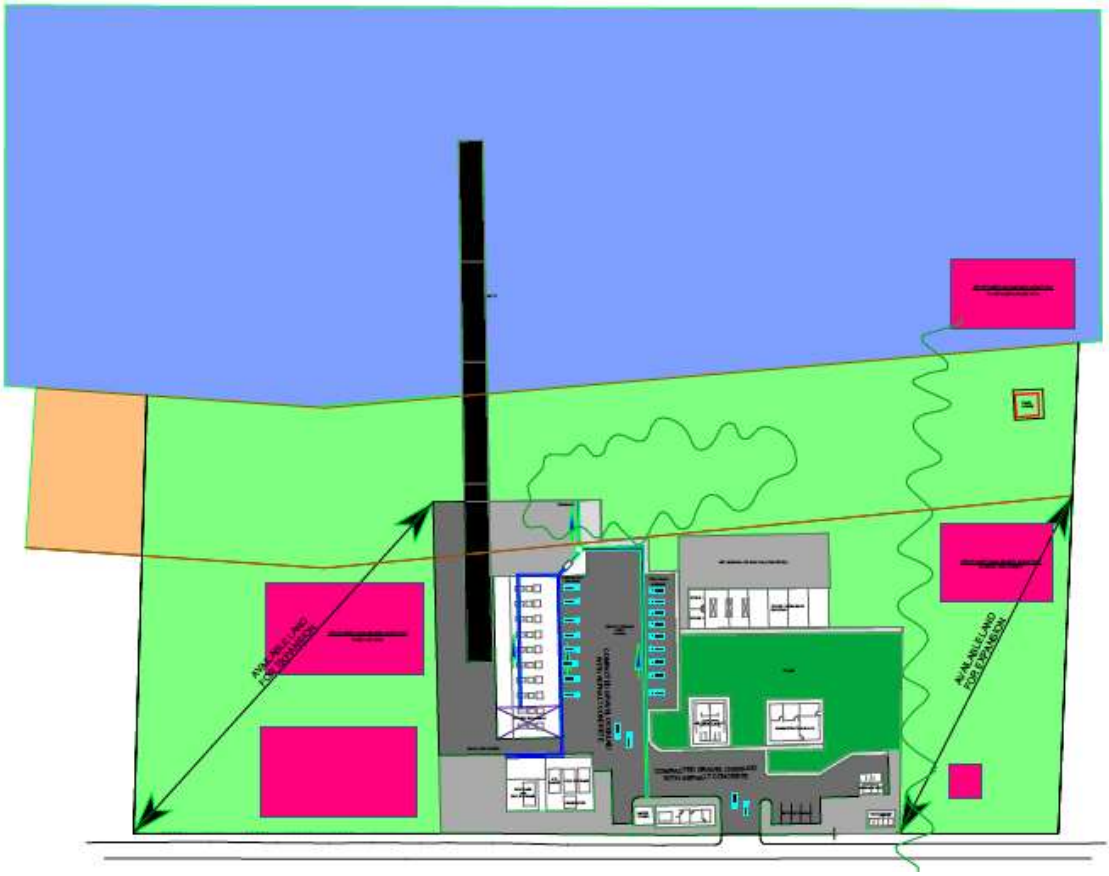
Figure 6 Present layout of Mwena Landing Site

Figure 7 Indicative bathymetry of Mwena Bay



Proposed site layout

Figure 8 Indicative site layout of Mwena Aquaculture Park



Recommended infrastructure and services

There will be additional infrastructure constructed at the landing site to support the Aquaculture Park development as illustrated in Figure 9 below. Additional infrastructure that will need to be constructed include;

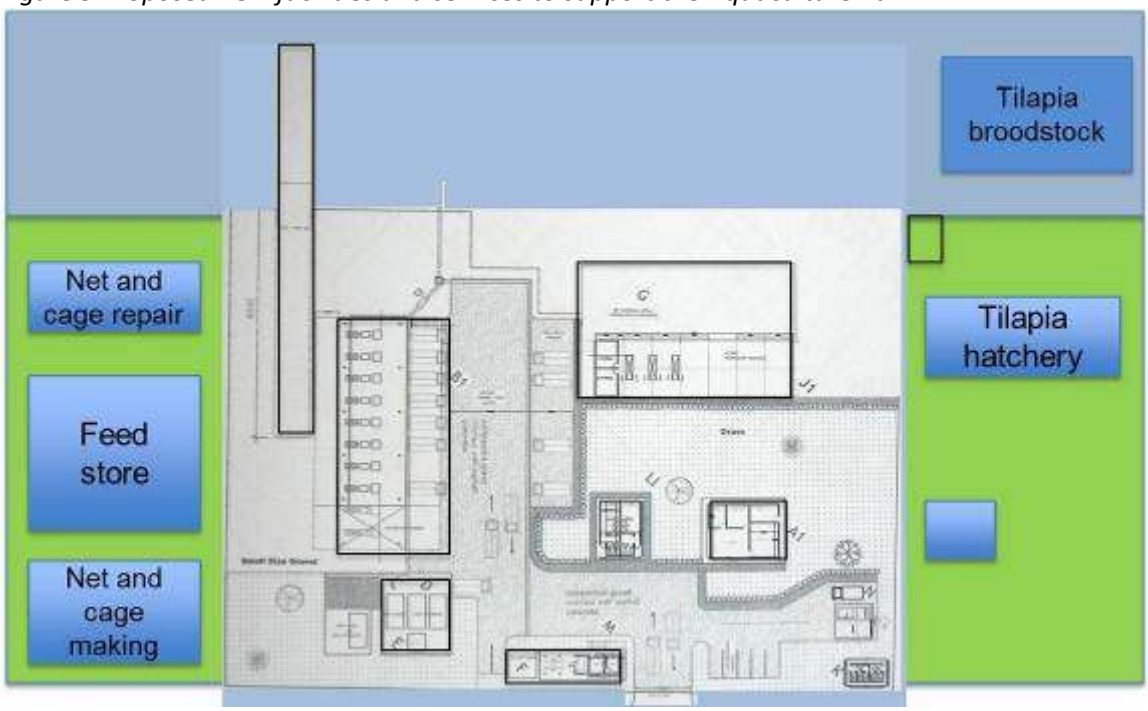
Feed store (500 m2). A feed store capable of storing 200 tonnes of feed in dry conditions protected from the sun and rain. Feed will be supplied in 20' containers delivered to the store by truck. Bags of feed will be delivered daily by the AP feed supply team to each set of cages on the request of each farmer.

Net making and cage making area. As the cages and nets will be assembled at the landing site, there should be an industrial type building for the assembly of cages and sewing of nets. There should also be a materials store connected to the net and cage making area to store the cage and net materials.

Net and cage cleaning and repair area. There should be shaded area with concrete plinth for cleaning and the repair/mending of cages and nets. This area should be provided with freshwater and a high pressure water pump for cleaning nets from any fouling material. Attached to this area should be a small maintenance workshop for the maintenance of mechanical equipment such as cars, outboard motors and pumps.

Tilapia Broodstock hapas. The Tilapia broodstock will be held in 12 sets of hapa cages. Each set will comprise of 2 cages of 2.5 x 2.5 x 2.5 m deep for females and one cage of 2 x 4 x 2 m deep for males. Eggs will be collected daily from the mouths of the females and separated by colour for different stages of egg development.

Figure 9 Proposed new facilities and services to support the Aquaculture Park



Tilapia hatchery. The Tilapia hatchery will comprise of an industrial building housing egg incubation jars and swim up fry collection trays operated using a water recirculation system. Newly hatched fry will then be transferred to small tanks for sex reversal. Sex reversed fry will then be transferred to nursery cages in the lake.

Pump house. The pump house will be upgraded with additional pumps and inlet and outlet pipes to supply additional water for the Tilapia hatchery.

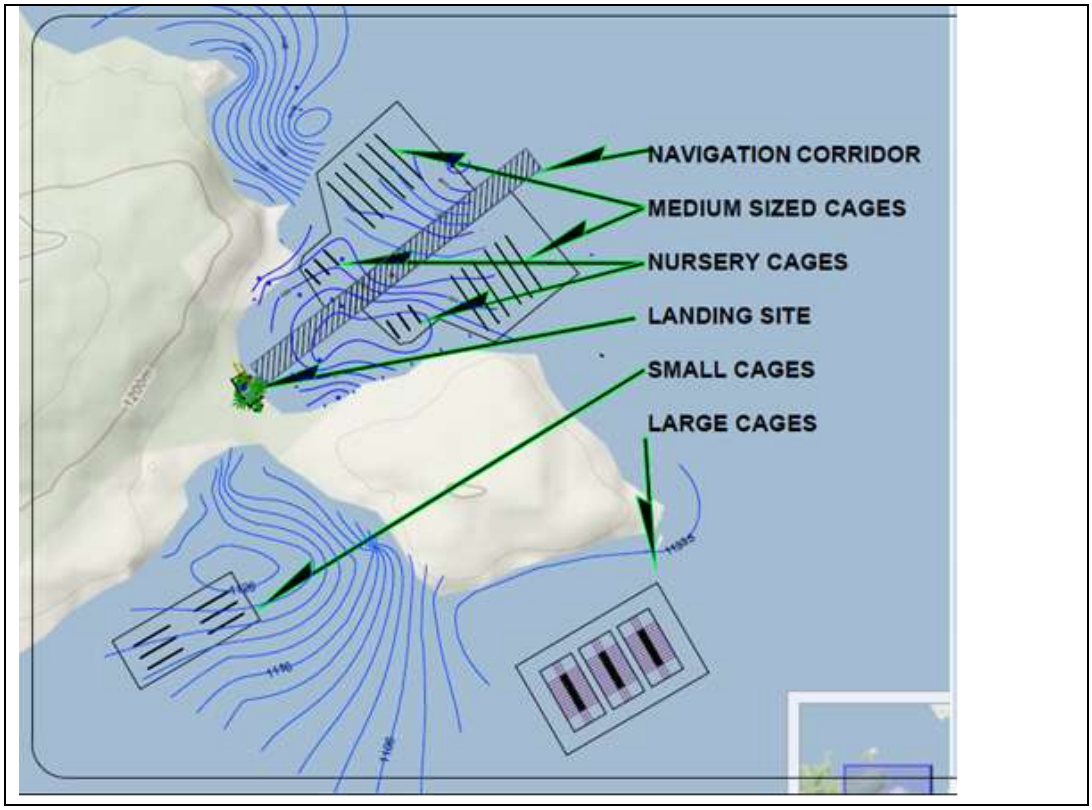
Administration and accommodation building. A separate 2 storey administration and accommodation building (100 m2 + 100 m2) will be constructed to be dedicated to Aquaculture Park management. The offices will be on the second storey to allow views of the cages in the bay and the accommodation for the Aquaculture Park technicians will be on the ground floor.

Security. The existing guard house at the main gate manned 24 hours. The new areas developed for the Aquaculture Park will be fenced.

Marketing. The existing marketing area will be readapted by building walls and insulating the roof. Cages with fish ready for the market will be towed to the jetty and harvested directly into insulated boxes with ice. The fish will them be transferred to the marketing building where they will be sorted (to remove deformed or damaged fish) and graded into 3 size groups (less than 350 g, between 350 and 550 g and over 550 grams). Traders will be allowed into the marketing building to purchase fish and load their trucks.

Floating Huts. There will be a floating hut installed for every 10 cages. This hut will provide shelter for the cage worker, temporary storage of feed and other essential items. The hut could be used as a security post if the producer wanted to have additional security of their cages.

Figure 10 Proposed location of cages


NAVIGATION CORRIDOR
MEDIUM SIZED CAGES
NURSERY CAGES
LANDING SITE
SMALL CAGES
LARGE CAGES

Timeline for implementation

Figure 11: Gantt chart for implementation of the cage based Aquaculture Park

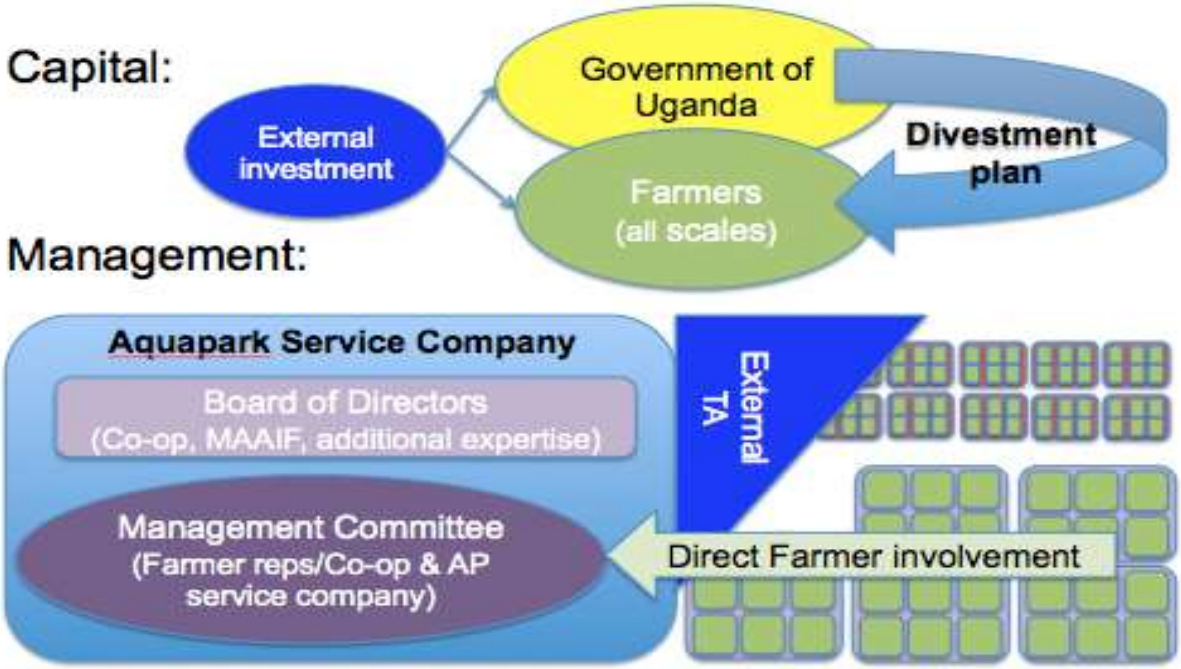
Responsibility	Days	Start	End	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15
MAAIF	**546**	**1-Jan**	**1-Jul**																																
MAAIF	411	**1-Jan**	**16-Feb**																																
MAAIF	360	1-Jan	27-Dec																																
MAAIF	21	27-Dec	17-Jan																																
MAAIF	30	17-Jan	16-Feb																																
MAAIF	**236**	**16-Feb**	**10-Oct**																																
MAAIF	30	16-Feb	18-Mar																																
MAAIF	45	18-Mar	2-May																																
MAAIF	90	2-May	31-Jul																																
MAAIF	90	2-May	31-Jul																																
MAAIF	90	2-May	31-Jul																																
MAAIF	15	2-May	17-May																																
MAAIF	10	17-May	27-May																																
MAAIF	45	27-May	11-Jul																																
MAAIF	30	11-Jul	10-Aug																																
MAAIF	15	10-Aug	25-Aug																																
MAAIF	30	25-Aug	24-Sep																																
MAAIF	10	24-Sep	4-Oct																																
MAAIF	5	4-Oct	9-Oct																																
MAAIF	1	9-Oct	10-Oct																																
Contractor	**310**	**10-Oct**	**16-Aug**																																
Contractor	30	10-Oct	9-Nov																																
Contractor	30	9-Nov	9-Dec																																
Contractor	90	9-Dec	9-Mar																																
Contractor	30	9-Mar	8-Apr																																
Contractor	30	8-Apr	8-May																																
Contractor	15	8-May	23-May																																
Contractor	20	23-May	12-Jun																																
Contractor	120	9-Mar	7-Jul																																
Contractor	120	8-Apr	6-Aug																																
Contractor	15	12-Jun	27-Jun																																
Contractor	20	7-Jul	27-Jul																																
Contractor	10	6-Aug	16-Aug																																

Recommended business model

A Public-Private Partnership (PPP) approach is favoured. The Government of Uganda would establish an Aquaculture Park Company. This may be in association with a large scale private sector partner that directly invests in the park or is paid a fee by the government to produce within the park on behalf of the government (the nucleus estate model).

Shares in the company are sold to investors that fit selection criteria – e.g. small scale investors should be from the area, and will commit to a Memorandum of Understanding detailing intention to produce using Good Management Practice. This share offer would recoup a proportion of the capital costs, but will mainly provide working capital for the farm (purchase of equipment, feed, labour, etc. ahead of revenue from production).

Figure 12 Aquaculture Park Company structure



The Government would provide the AP Company with a long-term lease and all necessary permitting for site production to an agreed level (up to 5,000t per site could be proposed if carrying capacity studies identify this as viable for the site).

The intention is for the public sector to support establishment of the park, but to ultimately divest itself of ownership of the park company (including the infrastructure built), while maintaining ownership of the land.

The Aquaculture Park Company would consist of a board of directors, providing regular strategic oversight of the company. Membership of the board could include shareholders such as large scale producers, farmer cooperatives and MAAIF as the government's responsible authority. There is also the useful potential to install external expertise on the board. The day-to-day management of the Aquaculture Park company would be driven by a management committee involving the AP company senior management and farmer representatives and/or co-operative staff. This would ensure direct farmer involvement in management of the farm to instil a sense of ownership by the farmers.

It is envisaged that substantial technical assistance (TA) should be provided in the first 18 month to 2 years of AP establishment. This TA should involve those with direct practical experience of successful Aquaculture Park establishment and operation.

Economic and financial analysis

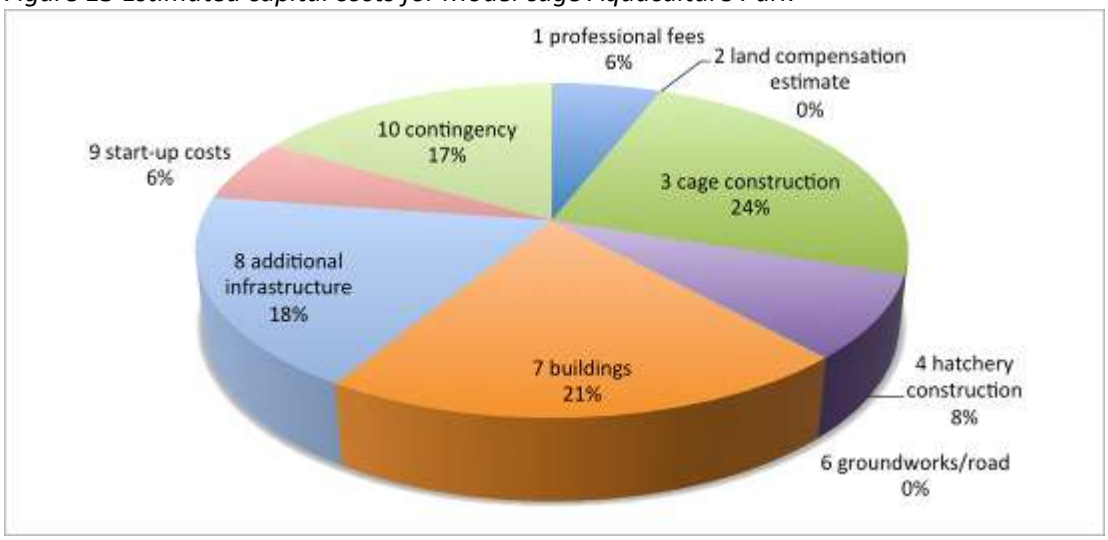
The Lake AP model using cage-based production is for Tilapia. The financial analysis presented below developed 4 business models (for small, medium, and large scale farmers plus the AP Company) as all scales of production must be viable businesses in order to sustain the AP Company.

Aquaculture Park Company

The Aquaculture Park base case involves 24 small scale farmers, 12 medium scale farmers and a single large operator. Together the maximum production of the Aquaculture Park amounts to 3,000 tonnes per annum or just over 8 tonnes per day.

The capital costs for the model cage-based Aquaculture Park amount to 8.2bn USH for a 3,000t production AP. Cage costs amount to 24% of total build costs and are likely to be phased. Around 80% of capital costs are assumed in year 1 with 5% each year after as more cages are constructed.

Figure 13 Estimated capital costs for Model cage Aquaculture Park



The balance sheet shows that when the Park achieves 40% production in year 3, a positive return is achieved. The first 2 years are loss making. In year 1 revenue relates to the money invested by the farmers (50% of the capital costs).

The cumulative cash flow shows the park enters a positive cash flow in year 7 and shows a good profit thereafter. However, if returns to investors are provided, it would take longer for cumulative cash flow to be positive. For example, assuming 50% of profits are returned to investors, it would take 8 years for positive cumulative cash flow. A quicker phasing in of production would reduce this timing as AP company profits increase substantially with scale of production. By year 6 with the park operating at 100% capacity and 50% of profits being returned to investors the small scale farmer would receive a 1millon/yr return, the medium scale 6 million/yr and the large scale investor 432million/yr. It would take 13 years for the initial investment to be repaid.

While the small scale investor is loss-making in the first year, both the small and medium scale investors see a good internal rate of return (IRR) after 5 years. This is not the case for the large scale investor, where -20% IRR is calculated for the first 5 years, becoming a more attractive IRR of 18% after 10 years. This investment should therefore be viewed as a long-term prospect by investors. When the AP achieves higher levels of production and all capital inputs have occurred (by year 6), good returns can be expected. Assuming inflation remains at 12% (year ending August 2012), down from around 19% in 2011, the IRR is 11% after 10 years.

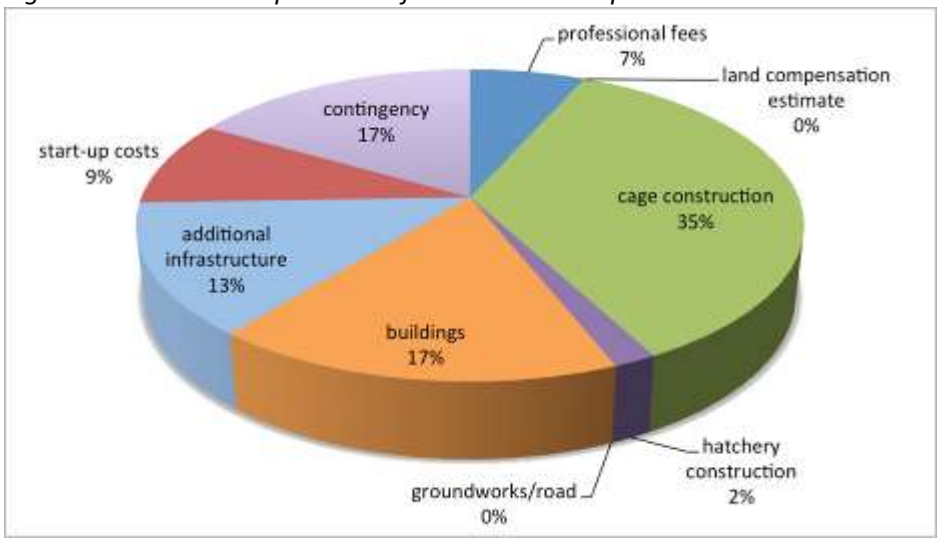
The need for a certain scale of production for the AP to be in profit makes it critical for the presence of a large scale operator at the start of the process. Private sector partners should be approached to seek their interest in the proposition. The AP provides a good opportunity for a large scale producer to quickly increase production capacity. There are many additional advantages to involvement in the AP: a suitable production site is passed to the producer with no development cost or delay in permitting

or land tenure agreements. However the level of investment (with a suggested 41% of shares in the AP company) is substantial and may be a larger initial investment compared to the producer building up production at a new or existing site. There may therefore be some negotiation over the level of and phasing of investment.

An alternative model is the nucleus estate (see section 0) where the public sector establishes the infrastructure and then pays private sector know-how to manage production on the site. This is a lower risk approach for the large scale producer as they are paid for a service and the AP can begin generating profits (for the government). Ultimately, the public sector should look to divest itself of the ownership of the AP company to the private sector when the model is shown to be working.

Mwena site:
The situation for the Mwena site is more positive than the model cage Aquaculture Park described above. As existing infrastructure can be used, capital costs amount to an estimated 5.6bn USH (4.5bn or 80% in the first year with the rest phased in regularly over following years). This is achieved through the use of the existing landing site structures, hence cost for buildings and additional infrastructure are reduced to 56% and 50% of the estimated cost for the model park.

Figure 14 Estimated capital costs for the Mwena Aquaculture Park site



AP Company profitability is entirely dependent on the overall production of the park. At 50% of capacity, producing 1,500t the company achieves 60% profitability. However at 20% (600t) profitability drops to 4% as some operating costs are to maintain infrastructure of a fixed scale. Based on the assumed revenue streams (i.e. 3% service charge, 5% marketing charge, 3% on feed and 10% on seed) the breakeven point for the AP company is at around 600 tonnes of production (
Table 9). A variation in the proposed charges would alter this breakeven point.

The assumed phasing (after a year of construction with no production) is 20% production (643t) in year 2, which is just above the breakeven point for the AP company in the current scenario. Production is then assumed to double year on year to reach 100% in year 6. One benefit of the phasing production in cages is the associated phasing of capital costs with 81% in year 1 and 5% thereafter as more cages are built.

The reduced capital costs of the Mwena site result in a more positive outcome for the farmer investors in the Aquaculture Park. Investments take 10 years to recover rather than 13 in the model case. The park would achieve positive cash flow in year 4 rather than year 8 in the model with the same 50% profit return to investors. An IRR of 15% after 10 years is achieved for the Mwena site.

Individual Farm performance

Table 3 presents the production assumptions for each scale of production. The key differences are that small scale producers use 25 small 2.5mx2.5mx2.5m cages and harvest at 350g, while medium and large harvest at 550+ from larger cages. The 12 medium farmers operate 50 cages of 4mx2mx3m while the single large operator uses 72 12m diameter round cages in deep water sites (25m+ depth).

The small farmers can then fit in two production cycles per pond per year, allowing more regular returns, but the medium and large farmers benefit from the higher price for larger fish. Mortality rates are assumed to decrease with scale of enterprise from 15% for small and medium scale and 10% for large.

Table 7 presents the annual performance of each scale of operator. Each scale is profitable, but profitability increases substantially with scale from 7% for small-scale producers, 28% for medium scale and 40% for the large scale producer. These figures include a 5% per kg marketing charge applied by the AP Company, which contributes to a gross profit of 78% for the AP Company. Removing this marketing charge obviously increases farmer profitability but decreases AP profits down to 45%. It should be noted, however that these profit levels are based on the park operating at 100% production capacity (3,000t per annum).

Table 6 Cage Aquaculture Park small, medium & large producers and Aquaculture Park company

1	small scale	2	medium scale	3	large scale	4	Aquaculture Park
farm volume	300	m3	1200	m3	81360	m3	100,000
cage size	2.5x2.5x2.5	m	4x2x3	m	12m diameter	farmers	24s, 12m,1 large
number of cages	40		50		72	cages	600s, 600m, 72 large
output target	800	kg/cage	1200	kg/cage	15000		3257
total output per cycle	32,000	kg per cycle	60,000	kg per cycle	1,080,000		n/a
size	350	grams	550	grams	550		350-550+
grow out cycle	6	months	7	months	7		continuous
mortality rates	0.2	%	15	%	10		10-20%
annual yield	32,000		80,143		1,527,429		3,257
price	6,000		8,000		8,000		6-8,000
total revenue	292 million		609million		11.6 billion		33 billion

Table 7 Financial performance of each scale of producer & AP company

	small scale		medium scale		large scale		AP
with 5% marketing charge	51.2	t	80	t	1,500	t	3,257
turnover	291,840,000	USH	609,085,714	USH	11,608,457,143	USH	33,011,293,714
gross profit	14867360	USH	173263885.7	USH	4870129371	USH	3,124,125,806
as % of turnover	5%		28%		42%		79%
per month	1,238,947	USH	14,438,657	USH	405,844,114	USH	206,733,900

Table 8 Sensitivity analysis for each scale of producer & AP company

small scale	**base case**	**profitability**	**25% less**	**profitability**	**25% more**	**profitability**
1. number of cages	40	5.0%	32	4.0%	50	6%
2. feed cost	2209.35	5.0%	1767	21.0%	2762	-14.0%
3. seed cost	126.5	5.0%	101.2	7.0%	158	3.0%
4. fish price	6,000	5.0%	4800	-18%	7500	23%
medium scale	**base case**	**profitability**	**25% less**	**profitability**	**25% more**	**profitability**
1. number of cages	50	28.00%	40		62	

2. feed cost	2209.35	28.00%	1767	39.0%	2762	15.0%
3. seed cost	126.5	28.00%	101.2	30.0%	158	27.0%
4. fish price	8,000	28.00%	6400	11.00%	10000	42.00%
large scale	**base case**	**profitability**	**25% less**	**profitability**	**25% more**	**profitability**
1. number of cages	72	40%	58		90	
2. feed cost	2209.35	40%	1767	50.0%	2762	28.0%
3. seed cost	126.5	40%	101.2	41.0%	158	39.0%
4. fish price	8,000	40%	6400	26.00%	10000	51.00%
Aquaculture Park	**total annual**	**profit**	**25% less**	**profit**	**25% more**	
1. production levels	3257	79%	2606	76%	4071	82.30%
2. build cost	8,274,913,471	3.3 yrs	6,619,930,777	2.7 yrs	10,343,641,839	4.1 yrs
3. electricity cost	380	79%	304	80.30%	475	78.60%

Table 9 Breakeven point for Model Cage-based Aquaculture Park

		number of cages			capital costs	costs per month			repay capital (yr)
Capacity	**yield**	**small**	**medium**	**large**		**gross profit**	**operating costs**	**Operating profit**	
100%	3257	600	600	72	8.2bn	260,343,817	53,609,917	79%	3.3
50%	1629	300	300	36	7.1bn	80,624,492	49,547,417	62%	7.3
20%	643	120	120	14	6.4bn	51,425,936	47,109,917	8%	123.6
15%	472	90	90	10	6.2bn	37,765,918	46,703,667	-24%	no

Annual balance sheets are provided for each scale of producer and the AP company (see Annex 9) It is expected that production in the AP will be phased. Phasing is a far easier task for a cage-based system than a pond-based system as it is a matter of constructing and deploying cages to support increased production targets. The small and medium-scale farm analysis is based on the use of commercial credit to acquire the shares, which is currently at 22% interest.

For the small and medium scale producers, capital costs are assumed to include the purchase of shares and the purchase of the necessary vessels. The key capital cost of cage construction is removed with the AP providing the cages, which is partly recouped by the service charge as an operational cost. The level of capital cost will mainly be dependent on the investment price set.

Capital costs of 8.2bn USH for the model cage AP equates to 83,257USH per m3 of production volume. For small scale farmers this amounts to 15.6millionUSH for 25 cages and 99.8millionUSH for the medium-scale farmers operating 50 medium sized cages. These investment amounts are at the upper end of what banks are willing to loan this scale of investor. The additional capital costs and operating capital required make the level of investment required non-viable for most would-be investors.

It is assumed for the purposes of this analysis that 50% of capital costs are recovered through the share offer and 50% from other sources such as equity funding. For small scale producers therefore invest 8 millionUSH per farmer and medium scale, 50millionUSH. By the same token the large scale operator would invest 3.3bn USH. With 24 small, 12 medium farmers this would yield 50% of the capital investment cost (small contributing 2%, medium 7% and large 41%).

As there are 24 small and 12 medium farmers, the individual investment represents a relatively small proportion of the operating costs (19% and 29% respectively). However for the single large scale operator, capital investment (including purchase of the large cages) represents a far more substantial investment (124% of annual operating costs).

Small scale:
Capital costs are assumed as 3.6million for wooden boat and outboard to service the cages and 8million for the purchase of shares and lease in the AP, totalling 11.6 million.

Working capital will also be required for the first year, for living expenses, seed and feed purchase. The total estimated loan is therefore 20million (the upper limit of bank loans to small scale farmers). Even at this loan level, it is expected that the AP may have to extend some credit to the farmer on seed and feed that would be recovered at harvest (6 months later).

With loan and interest repayments of 4.5million/year, the first 5 years gives a monthly income level of around 800,000USH while the loan is being repaid. This is below the 1million/month target, but monthly income rises above 1millionUSH when the loan is repaid.
An IRR of 54% after 10 years is achieved.

These estimates relate to the farm business only and do not take into account the shares in the AP company owned by the farmer, which would provide some additional income from year 3 onwards.

Medium scale:
Capital costs are assumed as 13.6million for 2 boats (fibreglass & wood) and outboards to service the cages and 50million for the purchase of shares and lease in the AP, totalling 63.6 million. With additional working capital required, a loan of 80 millionUSH is assumed. This is within the 50-100million USH indicated as a lending amount to medium-scale farmers.

As with the small scale farmers, with a monthly feed bill of 26 million when at full production, it is expected that the AP may have to extend some credit to the farmer on seed and feed that would be recovered at harvest (7 months later).
In the first year (assuming 1 harvest is possible) the farmer achieves a break-even position across the year. In year 2 a profit of nearly 13 million/month is achieved, taking loan repayments into account. An IRR of 216% is achieved after 10 years.

These estimates relate to the farm business only and do not take into account the shares in the AP company owned by the farmer, which may provide some additional income from year 3 onwards.

Large scale:
For the large scale producer, allocated a site rather than provided with the cages, capital investment will include the 12m diameter cages. Again their introduction is likely to be phased and 20/40/80/100% phasing is assumed.

The large scale farmer is assumed to invest 3.3bnUSH (41% of the capital costs). It is not anticipated this would come from a loan at the commercial rate of 22%. In total capital costs in year 1 amount to 4.3bn with 3.3.bn in AP investment, 900million in 14 x 12m diameter cages and 34.4million in boats to service the cages.

A loss is made in years 1 & 2 as the level of production is assumed to still be insufficient to cover the capital investment in the cages (a further 900million each year until all 72 cages are in place). Cumulative cash flow indicates a negative position until year 5 when the producer is assumed to be at 100% production and making good profits. An IRR of 68% after 10 years is achieved.

These estimates relate to the farm business only and do not take into account the shares in the AP company owned by the farmer, which may provide some additional income from year 3 onwards.

Summary

- The model cage Aquaculture Park is estimated to cost 8.2bn USH to build, the existing Mwena site reduces this cost to 5.6bn USH.
- At full capacity the Aquaculture Park, generating revenue from a variety of sources (seed and feed sales, marketing fee and a service charge) is highly profitable at 79%.
- The break-even point for the proposed 3,000t capacity Aquaculture Park is 600t (20% of capacity).
- With production assumptions based on improved culture practice, all scales of farmer are profitable, with those profits increasing with scale: 7% for small scale, 28% for medium and 40% for large.
- With the reduced borrowing for capital investment at Mwena, small scale investors achieve a positive NPV indicating it is worth investing in the park.
- With the combination of comparatively low investment costs and good profits, the results for the medium-scale investor are most positive.
- For the large scale investor with substantial capital costs in shares and cages, the park represents a long term investment.
- Returns on investment (based on 50% of company profits being distributed to shareholders) are achieved after 10 years at Mwena (13 years in the model case).
- A more positive outcome would be achieved with quicker phasing in of production.
- As the viability of the park company is dependent on a certain scale of production, which will mainly be derived from the large scale producer, an alternative approach is for the nucleus estate approach to be adopted where more of the capital costs are held by the public sector in the early stages, but the private sector would still manage production.

6 Pond-based Aquaculture Park Techno-economic Feasibility study

Proposed Aquaculture Park site of Apac (near Masindi port)

The Location of the proposed pond-based Aquaculture Park is on the banks of River Nile, where it leaves Lake Kyoga north of Masindi Port. A number of potential areas on the south-eastern bank were proposed in the Apac district.

Figure 15 Location of proposed site for pond-based Aquaculture Park, Apac

River Nile as it emerges out of Lake Kyoga

Potential areas for siting the Aquaculture Park

Site description and suitability

The River Nile is intended to act as a water source for supply to the ponds either by gravity or by pumping. If it is by gravity, the water is tapped from a location further upstream that is situated at a higher elevation through a diversion canal or a bulk water transfer pipe system to a reservoir. If the water is to be pumped, the pumping location should be within close vicinity of the reservoir so that the head to which the water is raised is kept to a minimum in favour of limiting operational costs so as to maximize the profits.

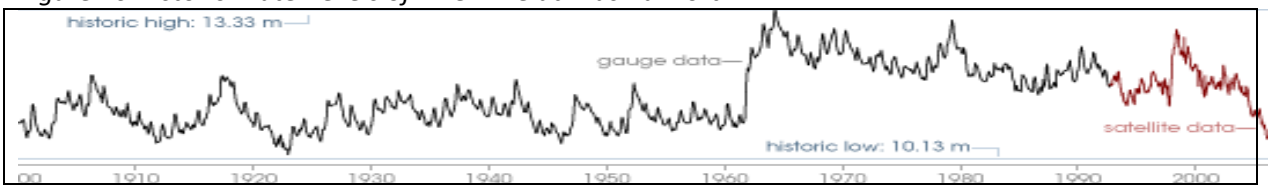
The region identified for the land based feasibility study resulted in the identification of 2 main potential sites for a total fish production turnover of 2,380 tons per year. One of the sites is close to Masindi Port and the other is 24 kilometers away along the Apac – Lira road. Both sites have potential with the Apac site having mores space between river and road, but a detailed topographic survey would be required to confirm overall suitability.

Land tenure is a critical factor in the viability of land-based parks where substantial land areas (200ha in this case) are required. The land is largely owned by individuals or families. Because of such a system of land tenure, setting up a gravity flow system would be very difficult indeed due to the obvious resistance that would be met from land owners.

The preferred Aquaculture Park design model is for water pumping into a reservoir from where the distribution then takes place by gravity. Pumping is a significant additional operation cost. It would be worthwhile to consider a “micro” hydro power plant given such site characteristics.

It should also be remembered when siting the pump in the river, that due to the chocking of the Victoria Nile outlet of Lake Kyoga by floating suds, river levels have dropped by 1.6 meters historically (Figure 16). This serves as a precaution to site the pump at a level lower than this, 2m in the case of this design.

Figure 16 Historic Water levels of River Nile at Masindi Port



The topography of the site was found to be a little too steep across its width compared to the preferred range, but this can be addressed using the right cut and fill proportions during construction. Along the length, there is sufficient elevation for gravitational flow.

The typical design conceived for the land based Aquaculture Park characterizes a clean zone consisting of the supply water reservoir, the hatcheries and nurseries, gradually moving through the small ponds and the large ponds towards the waste / effluent zone.

For optimum water utilization efficiency, the Aquaculture Park effluent water, being loaded with nutrients, is recommended for irrigation of crops to improve crop yields in comparison to the use of fresh river water or rainwater.

Recommended culture system

Both tilapia and African catfish can be produced from land-based Aquaculture Parks.
In the land based Aquaculture Parks the systems used should permit production levels that shall result in:

i. A minimum income level of USh. 1,000,000/= per month small-scale operators.
ii. Enable the Aquaculture Park earn enough to cover its operational and maintenance costs particularly for water pumping, electricity, marketing, provision of technical services and general maintenance.
iii. Easily adaptable to both tilapia and catfish.
iv. Easily adaptable to small, medium and large scale operators.
v. Allows of intensification without major infrastructural adjustments.

Thus pond production is the preferred production units of operation with tanks as supplementary units in hatchery operations, temporary holding facilities in marketing unit and intensive catfish rearing. To achieve the above, the break-even production level for each grow-out operational unit (i.e. farm/holder) is at 15 tons/ha at current farm-gate prices for table fish. To achieve this, production units need be managed at higher intensities than is currently the case in the 'static water non-aerated systems' commonly used. Units shall therefore need to be stocked at higher densities, aerated, be feed-based depending on high quality feeds and stock fingerlings of high quality (Table 10 and Table 11 below).

Table 10 Options for pond-based Tilapia production

Key Parameters	Input Levels			
	Current Systems		Aquaculture Park Systems	
	Option 1	Option 2	Option 1	Option 2
Stock	All male/Mixed sex [a]	All male/mixed sex[a]	All male	All male
Carrying Capacity	3-5 tons/ha	10 tons/ha	20 tons/ha	20-30 tons/ha
Water Quality management	Static Water	Static Water	Aeration early morning	25% water exchange and aeration
Feed	Supplementary on-farm made feeds	Sinking pellets or extruded feed, 25% CP; max input level 10 g/m^2.	High quality extruded; min 30% CP; max. input level 20 g/m^2	High quality extruded; min 30% CP; max. input level 30 g/m^2
Fertilization	Green water – to provide nutrition and for water quality management	Green water – to provide some nutrition in early months and water quality management	To maintain water quality, not for nutrition.	None.
Yield	10 tons/ha/crop[b]	10 tons/ha/crop[b]	20 tons/ha/crop[b]	20-30 tons/ha/crop[b]

[a]Stock 10% and 30% catfish for population control when all males or mixed sex are stocked respectively.
[b]Specific number produced depends on targeted market size. Currently the marketable for pond raised tilapia around major towns is +300g per fish. Up-country farmers can sell off their tilapia from an average size of +200g per fish.

Table 11 Options for Catfish Production

Key Parameter	Input Levels		
	Option 1	Option 2	Option 3
System	Ponds	Ponds with aeration	Tanks

Carrying Capacity	20 tons/ha	35 - 40 kg/m3	50-70 kg/m3
Water Quality management	Static water, top-up for evaporation, H20 exchange towards carrying capacity.	Static water, early morning aeration	Complete water exchange and aeration.
Feed	High quality extruded; min 30% CP; max. input level 20 g/m^2. Max economic FCR ≤1.8	High quality extruded; min 35% CP; max. input level 40 g/m^2 . Max economic FCR ≤1.8	High quality extruded; min 35% CP; max. input level 50-70 g/m^3 Max economic FCR ≤1.5
Fertilization	None	None	None
Yield	20 tons/ha/ha/crop[a]	35-40 per/ha/crop	50-70 per/ha/crop

[a]Currently marketable size for table catfish is +800 g.

Land Based:

The land based Aquaculture Park will comprise of ponds and tanks, with ponds dominating. This;

- can easily be adapted to either tilapia and catfish
- Intensification possible without major infrastructural adjustments
- adaptable to small, medium and large scale operators
- maintenance requirements cover the aqua-park operations and maintenance costs and ensure good income level for operators.

It ensures that it will be profitable to individual operators with an income level for small holder greater than UGX 1,000,000/= per month.

Cover Aquaculture Park operational costs, notably:

- Water supply, including pumping
- Provision of technical services
- Electricity
- Marketing
- General maintenance

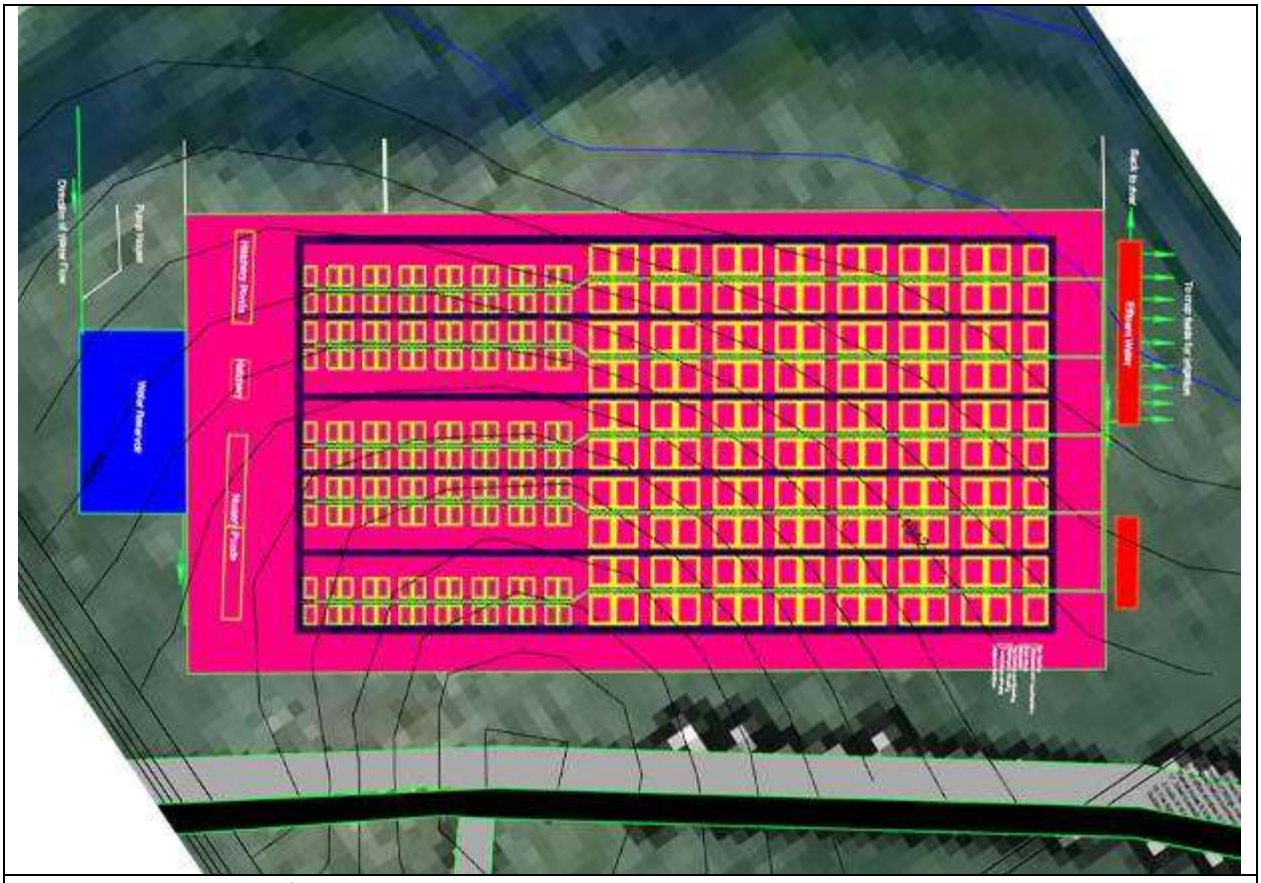
This implies operations must be able to produce at least of 15 tonnes/ha at current farm-gate prices for table fish.

To achieve this, production units will have to be:

- Stocked at higher densities
- Aerated – as the ponds will have static water
- Feed-based – need for high quality feeds
- Good seed quality.

Site layout

Figure 17: Proposed layout of the land-based Aquaculture Parkclose to Masini Port

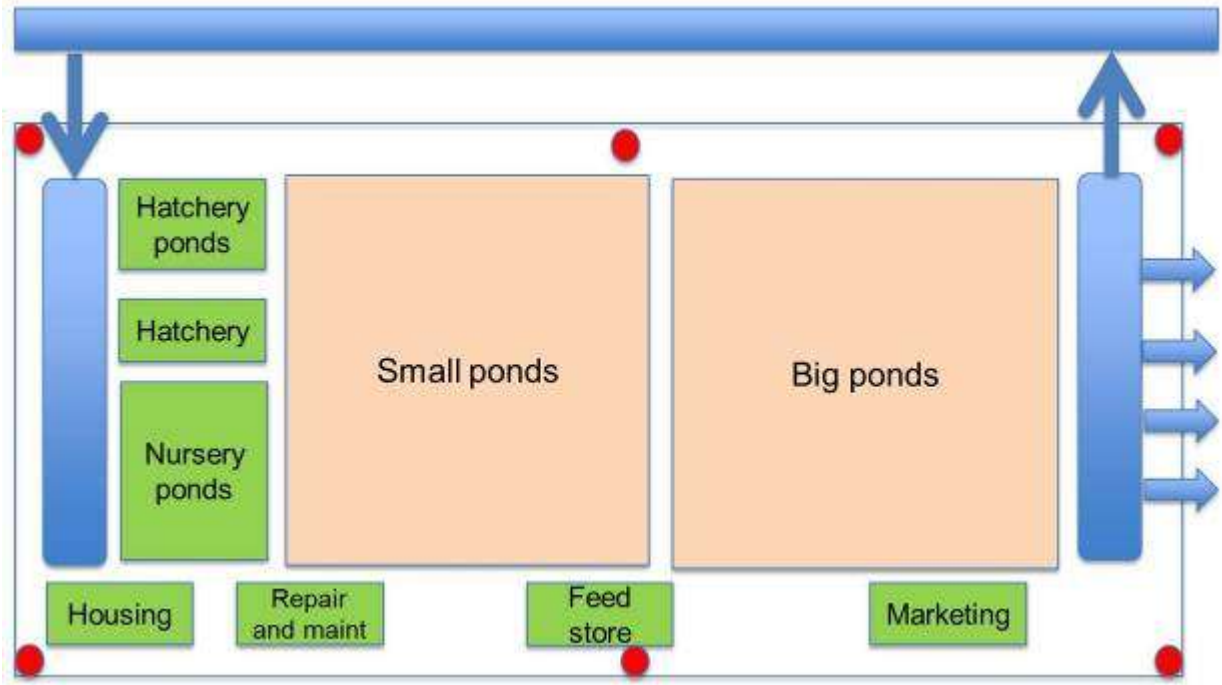


Proposed site layout of the pond-based Aquaculture Park

The support service facilities, namely marketing and administration, feed store, workshop, net making, repair and drying shed, wet store and on-farm staff accommodation and sanitation facilities in that order of proximity to the main entrance gate, such that visitor / buyer mobility is restricted and kept as far away from the production area as possible. It would also be wise to have high perimeter dykes to guard against the possibility of flooding. These dykes also serve as security quarter guards over the entire Aquaculture Park area.

The infrastructure and services required to be constructed at the pond Aquaculture Park include services for operation and maintenance and services for harvesting, packing/processing and marketing;

Figure 18:. Schematic layout of the land based Aquaculture Park



Recommended services and facilities

Infrastructure and services that will need to be constructed include;
Pump house. There will be a pump house that takes water from the Nile River and discharges into an inlet supply channel and inlet distribution reservoir. There will be 3 diesel pumps and 3 electricity pumps. There will be emergency generators capable to powering the electric pumps and aerators. There will be water supply channels that supply the hatchery and each pond individually.

Broodstock ponds. There will be ponds dedicated to holding Tilapia and catfish broodstock for breeding and supply of eggs to the hatchery.

Hatchery. There will be a hatchery building for catfish fry production (but is also capable of producing Tilapia swim up fry).

Nursery. There will be dedicated Tilapia and catfish nursery ponds.

Feed store (500 m2). A feed store capable of storing 200 tonnes of feed in dry conditions protected from the sun and rain. Feed will be supplied in 20' containers delivered to the store by truck. Bags of feed will be delivered daily by the AP feed supply team to each pond based on the request of each farmer.

Maintenance workshop and repair area. There will be a maintenance workshop for the maintenance of mechanical equipment such as cars, aerators and pumps. Attached to the workshop will be a store to house spare parts.

Administration building. A separate 2 storey administration and training building (100 m2 + 100 m2) for the Aquaculture Park management. The offices will be on the second storey to allow views of the ponds and the training and meeting rooms on the ground floor.

Accommodation buildings. A separate accommodation rooms for the AP Farm Manager and section managers, a block to house AP farm technicians and another block for AP labourers.

Effluent canals and treatment. Each pond will be connected to effluent discharge canals that drain by gravity into an effluent settling pond before being discharged back into the river or used for irrigation of crops.

Security. There will be 6 security posts along the perimeter fence that are manned during the night and a guard house at the main gate manned 24 hours.

Marketing. There will be a large marketing area housed in an insulated building. Fish will be harvested directly from the ponds by the AP harvesting team and harvested directly into insulated boxes with ice. The fish will them be transferred to the marketing building where they will be sorted (to remove deformed or damaged fish) and graded into 3 size groups (less than 350 g, between 350 and 550 g and over 550 grams). Traders will be allowed into the marketing building to purchase fish and load their trucks.

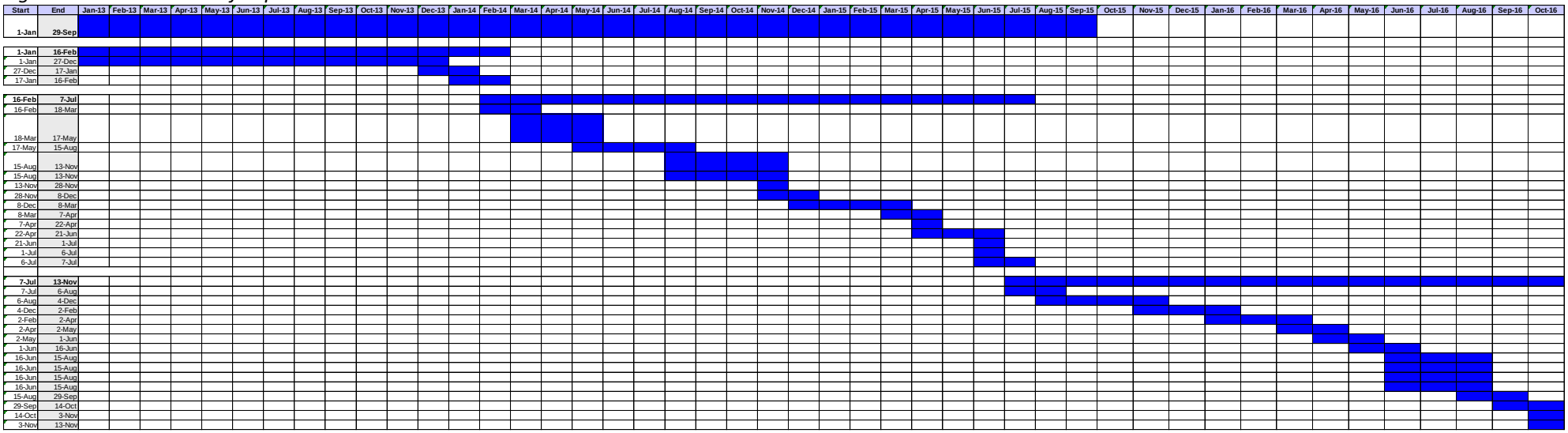
Ablution blocks. There will be common ablution blocks constructed for each row of ponds. Each ablution block will comprise of male shower and toilet and female shower and toilet.

Huts. There will be a hut installed for every 4 ponds. This hut will provide shelter for the pond worker, temporary storage of feed and other essential items. The hut could be used as a security post if the producer wanted to have additional security of their ponds. An electrical outlet will be provided next to each hut to supply electricity to aerators at night and early morning.

Time line for implementation

It is estimated that it will require 2 years for the farm to become operation due to the time required for securing the site, permits and construction of the facilities.

Figure 19: GANTT Chart of implementation



Recommended business model

The business model for the pond-based Aquaculture Park is the same as that proposed for the cage-based system. A key difference is that it is less realistic for capital costs to be phased in, irrespective of the need or likelihood of phased production. Construction would take longer (18 months is estimated) and the bulk of the pond construction should occur at the start to minimise the risk of construction affecting water quality in existing ponds and reduce the costs of mobilising and demobilising heavy plant equipment.

As with the cage-based model described above, the business model involves a mix of small, medium and large scale farmers that invest in the Aquaculture Park Company, receiving shares in the company and a lease to produce in the park where they would be allocated a certain number of ponds, depending on the level of investment.

Again, the dependence on a certain scale of production suggests that a large scale produce needs to be in place from the offset – this may be through a single large private sector producer investing in the AP or through the nucleus estate model where the government commissions private sector producers to produce on the AP.

The base case model involves a grow out area of 150 small ponds of 40m x 50m and 150 larger ponds of 60m x 80m. The pond-based AP is flexible to enable a mix of tilapia and catfish production, the later showing itself to be slightly more profitable on current assumptions and likely to be favoured by some small-scale producers.

Economic and financial analysis

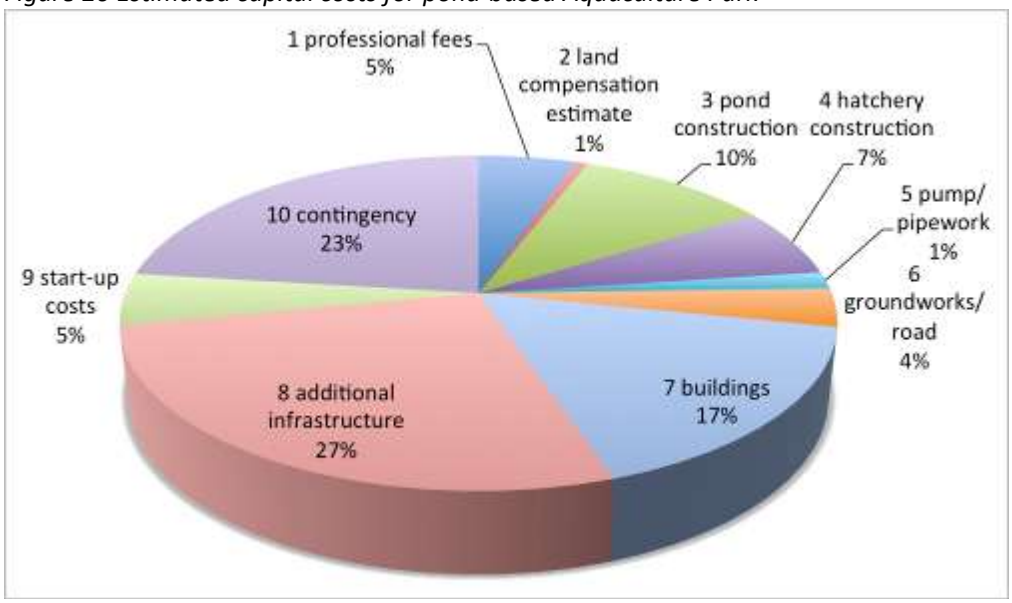
Aquaculture Park

The estimated capital cost for the pond-based Aquaculture Park model producing around 2,380t at full capacity is 9.6bn USH, including a 25% contingency on build costs, which have been increasing in Uganda. This level of production requires 150 small ponds and 150 large ponds. The proportional breakdown of costs is presented in Figure 20. The capital costs equate to 10,000USH per m2 of production area.

The scale of the capital costs suggests it is unlikely that small scale farmers could invest on the basis of 50% of the capital costs proportional to production area (as proposed in the cage model). 50% in proportion to production area equates to 56millionUSH for the 19 small scale producers (operating 8 ponds), 135million for the 17 medium scale producers and 1.1bn for the single large scale operator. The pond-based model indicates a larger scale of production for the small and medium-scale compared to the cage-based system where investment could start at 8 million. This suggests that a co-operative approach may be favoured on the pond-based Aquaculture Park model will farmers linking up to invest in pond culture. The consequence of this is a lower level of capital investment for the large scale producer compared to the cage-based model.

A construction time of 18 months is assumed, resulting in no production in year 1 and only 40% in year 2. A phased production of 40% on years 2 and 3, 80% in years 4 and 5 and 100% from year 5 onwards is then assumed. Revenue from seed, feed, marketing and a service charge amounts to 2.3bn USH at full production capacity (2,380t) giving a profit of 51% to the service company. The break even point for the service company is 1,120t which is the equivalent of 70 small and 70 large ponds operating at full capacity (see Table 14).

Figure 20 Estimated capital costs for pond-based Aquaculture Park



A balance sheet for the Aquaculture Park Company is provided in Annex 9. At full production the AP would take 8 years to repay the capital costs, but with phased production and returns to investors, repayment extends to 14 years. This is around the same length of time for investors to recoup their initial investment at 50% return on profits.

The IRR is -6% after 10 years.
The benefits of investment should be recognised as the lease providing the opportunity to farm at a profit, not just an opportunity to make money from the investment in the Aquaculture Park company.

Individual Farm Performance

(see tables 9,10 & 11)

Small scale

The base case proposes 19 'small scale' farmers each managing 8 small ponds (40m x 50m). Each farm would produce up to 35tonnes of tilapia per annum, assumed to be harvested at 350g after 8 months. This results in annual revenue of just over 200millionUSH, giving a 19% profit at 3.2millionUSH per month.

Catfish production (harvesting at 1kg after 9 months) is shown to be more profitable with 39 tonnes yielding a profit of 23% (3.9millionUSH/month)

Sensitivity analysis (Table 14) indicates that the proposed scale of 8 ponds per small scale farm is critical to profitability as 6 ponds results in a slight loss (-4%), while an increase to 10 ponds increases profitability to 34%. Feed cost is also critical to profitability, representing 80% of operating costs.

The price of fish is also a critical variable with 25% lower price leading to a loss. The opportunity to grow tilapia larger and achieve a higher price would remain open to all farmers, a conservative position is assumed where small-scale producers may be in need of revenue sooner and service local markets and may therefore harvest sooner at 350g.

Based on an AP investment of 56million per farm, cash flow becomes positive in year 3, with an IRR of 29% after 10 years.

Medium

The base case proposes 17 medium scale farmers each managing 6 large ponds (60m x 80m). Each farm would produce 67.5tonnes per annum. These achieve a profit of 31% based on the production assumptions based on improved farm practice in Uganda.

The NPV for the medium-scale farm is positive when loan repayments (for the 135million investment in the AP) and operating costs are compared to expected revenue. The cash flow is positive from year 1, even with the reduced revenue in year one and the IRR is 291% after 10 years. This perhaps represents close to an optimum scale of production within the pond-based AP

Large

The large-scale farmer (operating 50 large ponds) producing nearly 600tonnes per annum is the most profitable scale of farmer at 38% profitability. Profitability is achieved in year 4, taking into account loan repayment on 1.1bn USH investment in the AP. The loan is assumed at the same commercial rate of 22% as the smaller scales, although such an amount is likely to be financed through other means at lower rates, making this a conservative assumption.

An IRR of 53% is achieved after 10 years.

Summary

- Capital costs of 9.6bn USH are estimated for the pond-based Aquaculture Park
- Investment in the park, even for the smallest viable scale, is unlikely to be open to small-scale farmers (56million assuming 50% of capital costs recovered by farmer investment). Groups of farmers, potentially under a co-operative structure are more likely investors.
- Investment by the large-scale operator is at a lower level than the cage-based model as it represents around 24% of production area compared to 80% for the cages.
- While investment in the AP company should provide returns in the long term, it should be viewed as providing access to the benefits of operation within the AP, i.e. the ability to estab-

lish production at a far lower capital and operating costs than operating alone. Therefore the production lease is more important than the shares.

- All scales of farm considered are profitable, providing good levels of return after various (service & marketing) charges are paid to the AP company.

Table 12 Pond Aquaculture Park small, medium & large producers and Aquaculture Park company

	Small scale		Medium scale		Large scale
Production targets					
farm area	16,000	m2	28,800.00	m2	240,000.00
output target	2	kg/m2	2.51	kg/m2	2.51
output per cycle	32,000	kg per cycle	72,200.00	kg per cycle	601,666.67
size	350	grams	550.00	grams	550.00
grow out cycle	8	months	10.00	months	10.00
mortality rates	0	%	15.00	%	10.00
annual yield	35,200		67,507.00		595,650.00
price	6,000		8,000.00		8,000.00
total revenue	200,640,000		513,053,200.00		4,526,940,000.00

Table 13 Financial performance of each scale of producer & AP company

	Small scale	Medium scale	Large scale
Profit	38,899,836	158,405,455.49	1,728,397,229.11
profit as % of turn-over	19%	31%	38%
Profit per month	3,241,653	13,200,454.62	144,033,102.43

Table 14 Sensitivity analysis for each scale of producer & AP company

		base case	profitability	25% less	profitability	25% more	profitability
small scale	1. no. of ponds	8	19	6	-4%	10	34%
	2. feed cost	2209.35	19	1767.48	33%	2761.6875	3%
	3. seed cost	132	19	105.6	20%	165	19%
	4. fish price	6,000	19	4800	-6%	7500	35%
		base case	profitability	25% less	profitability	25% more	profitability
medium scale	1. no. of ponds	6	31%	4	32%	8	30%
	2. feed cost	2209.35	31%	1767.48	42%	2761.6875	17%
	3. seed cost	132	31%	105.6	31%	165	30%

	4. fish price	8,000	31%	6400	9%	10000	44%
		base case	profitability	25% less	profitability	25% more	profitability
large scale	1. no. of ponds	50	38	40	39%	62	37%
	2. feed cost	2209.35	38	1767.48	49%	2761.6875	25%
	3. seed cost	132	38	105.6	39%	165	38%
	4. fish price	8,000	38	6400	19%	10000	50%

Aquaculture Park		**base case**	**repayment**	**25% less**	**repayment**	**25% more**	**repayment**
1. build cost		9.5bn	8.15	7.6bn	6.12	11.9bn	10.2
			profitability	**25% less**	**profitability**	**25% more**	**profitability**
2. electricity cost		380	51%	304	52%	475	49%
3. head height (pumping)		3.3metres	51%	2.64	56%	4	45%
4. production levels		2381	51%	1904.8	43%	2,976	58%

Breakeven point

		number of ponds			**capital costs**		**costs per month**		**profit**	
Capacity	**yield**	**small**	**medium**	**large**		**profit**	**operating costs**	**operating profit**	**% of turn-over**	**years pay c**
100%	2381	150	100	50	9.7bn	192,258,885	94,549,630	101,084,256	52%	
50%	1190	75	50	25	9.1bn	97,816,943	91,456,016	6,360,927	7%	
20%	476	30	20	10	8.8bn	39,126,777	89,599,847	-50,473,070	-129%	

7 Community Aquaculture Park

At the request of MAAIF, the consultants were asked to assess the suitability of 2 types of irrigation scheme close to Lira.

- Integrated aquaculture agriculture buffer dam Irrigation scheme
- Valley tank aquaculture agriculture irrigation scheme

Figure 21 Location of potential Community Aquaculture Park near Lira

Location of irrigation schemes close to Lira

Rice irrigation scheme layout

These irrigation schemes are supplied water from seasonal water supplies. The Buffer dam collects water from the watershed and distributes it via canals to rice fields before the water drains back into a central canal. At present the buffer dam is not used to hold water.

There is potential to put a small Aquaculture Park just below the buffer dam and pass the irrigation first through the Aquaculture Park and then direct the nutrient enriched effluent water from the Aquaculture Park to the rice fields below. This integrated aquaculture/Aquaculture system could then produce fish as well as improve rice yields.

The seasonal nature of the water supply would restrict fish production to 1 crop per year (8 -10 months) and the ponds would remain dry for the remaining time. It is therefore suggested that a community-based Aquaculture Park many be possible. This would have smaller production levels to the commercial scale parks proposed in the previous section. The lack of income during the dry periods when no fish production is possible would have to come from alternative crops grown by the farmers operating in the AP.

The concept of multi water use and integrated Aqua-Agriculture is worth developing for community based Aquaculture Parks to provide additional livelihoods, food security and income to local communities and at the same time improve productivity of the existing agriculture. However, the scale of production would be much lower than the commercial scale Aquaculture Park concept that is being developed in this study.

Figure 22 Potential location of a Community Aquaculture Park near Lira

Community Aquaculture Park located immediately below the buffer dam.

However the community Aquaculture Park concept is still a valid model for

- the provision of livelihoods to local communities
- the integration of aquaculture and agriculture for mutual benefit
- to utilise the existing and newly planned crop irrigation schemes for fish production and improved crop production

8 Planning and Management of Aquaculture Park Development

Aquaculture Park framework

The Policy on Aquaculture Park establishment and development was adopted by MAAIF/DSIP, and is in line with the National Development Plan. This policy takes into consideration other aquaculture related issues contained in other policies especially those for water, land and environment. Its implementation therefore will be a shared responsibility by all stakeholders involved in the promotion of aquaculture.

The institutional framework for implementation of the AP policy takes into account the decentralized system of governance. The Ministry of Agriculture, Animal Industry and Fisheries is the lead agency for the implementation while collaborating closely with other Ministries and agencies that have a role in aquaculture planning and management.

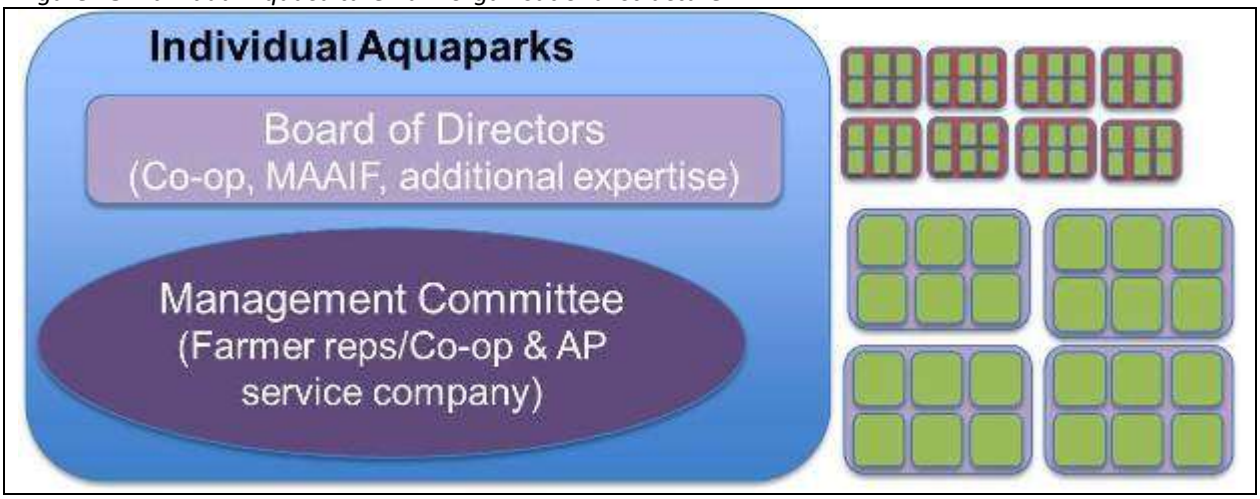
The framework should be based on the development of profitable aquaculture business and the management of resources (including social, environmental, economic, technical, and political) for the benefit of the livelihood of the community and food security for the country. This is process-driven, interactive and complementary.

The Aquaculture Park Framework is a means by which “good governance” in aquaculture is achieved: it is an open, transparent, process that brings all the stakeholders around the table to reach a consensus and to coordinate the identification, setting-up, operation and monitoring of an Aquaculture Park. If this Framework is implemented, from conception to implementation and with monitoring and evaluation), better governance of the sector will be achieved.

Individual Aquaculture Park organisational structure

The Aquaculture Park Management Company is a legal entity with shareholders, a board of directors and a management committee (see Figure 23).

Figure 23 Individual Aquaculture Park organisational structure



The following structure and functions of the Management Committee and the Board of Directors is proposed:

Aquaculture Park Management committee (to meet monthly)

- Chairperson (farmer)
- 3 Producers
- Hatchery manager
- Farm Manager
- Marketing manager
- Representative from the local community

Duties

- Coordinating stocking of ponds/cages with fry
- Coordinating harvesting of fish from ponds/cages
- Coordinating farmer training programmes
- Ensuring record keeping of production and accounts
- Coordinating regular environmental monitoring and management
- Ensuring good local community relations
- Conflict resolution

Aquaculture Park Board of Directors (meet biannually)

- Chairperson (MAAIF representative)
- 5 Producers
- Hatchery manager
- Farm Manager
- Marketing manager
- District Fisheries Officer
- District Production Officer

Duties

- Oversight of Management committee decisions and actions
- Developing long term production and management strategy

Regional & National Aquaculture Park Organisation

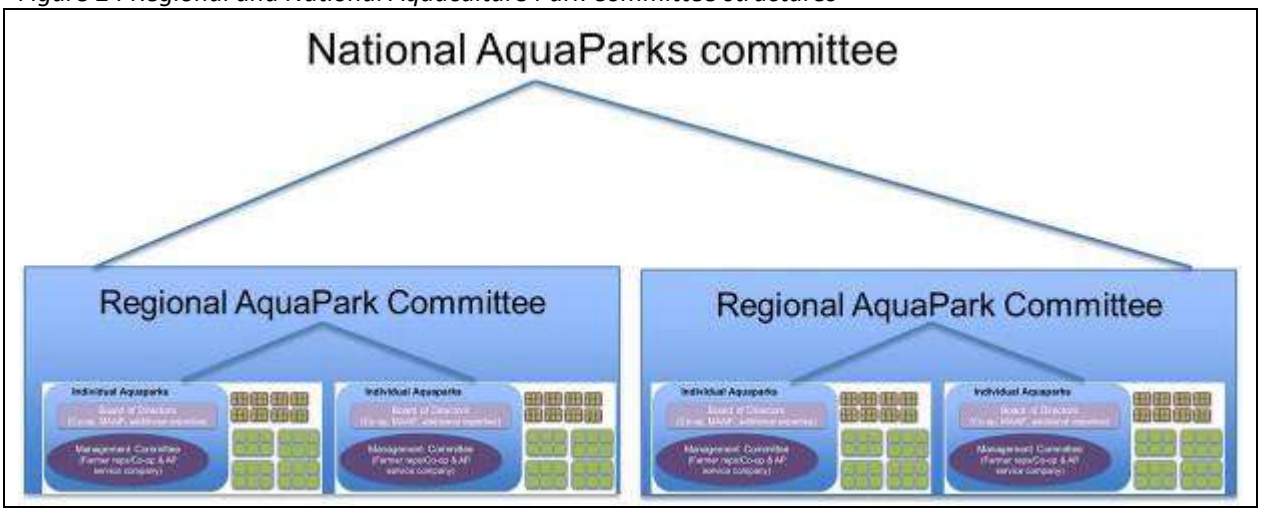
With the successful implementation of one or two pilot Aquaculture Parks, comes the prospect of several APs within a district or region. There should be regional co-ordination between the Aquaculture Parks via a Regional Aquaculture Park Committee that would enable:

- Sharing experiences and addressing issues;
- Co-ordinated marketing (to ensure the Aquaculture Parks are not competing with each other and a consistent supply of fish enters the market);
- Linking into wider regional planning.

The Regional Committees should also link together under a National Aquaculture Parks Committee (, which has a similar function, but at a national level and will contribute to the development of AP policy and aquaculture development in Uganda.

Although the user-based committees are important components for successful implementation of Aquaculture Parks, the development of Aquaculture Parks in Uganda requires support from a dedicated team within MAAIF. An Aquaculture Parks Coordination Unit (APCU) located in Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is proposed. The APCU should facilitate the development of Aquaculture Parks and prepare an agreed Aquaculture Park Development Plan. This would be achieved through liaising with UIA, Private Sector, Ministry of Lands and Urban Development, Ministry of Finance, Planning & economic Development, NEMA, Local Governments and Development.

Figure 24 Regional and National Aquaculture Park Committee structures



Aquaculture Park development plan

The Aquaculture Park development plan should provide guidelines for the establishment and management of Aquaculture Parks based on a transparent process in close consultation with stakeholders based on the best available information.

By following the guidelines (outlined in this report) it will help to develop holistic aquaculture planning and management systems that seek the sustainable and equitable use of the Aquaculture Park (ecological and human) to best meet the community's needs and values. The purpose of the process is to develop and implement an integrated set of planning and management arrangements for the Aquaculture Park to generate more acceptable, sustainable and beneficial community outcomes.

Role of Central & District government, the private sector and farmers

Role of Central Government

The MAAIF shall be responsible for the following:

- Regulation and support of all aquaculture production activities and practices
- Research and Development of Aquaculture Production Systems and Technologies
- Put in place mechanisms for security
- Provide all AP farmers public sector support and guidance.
- Register producers and ensure that they take a mandatory training in management and utilization of Aquaculture Parks prior to being considered for user rights in the Aquaculture Parks as leases
- Ensure that aquaculture inputs and materials have tax exemption like all other agriculture inputs including fish feeds
- Technical backstopping supervision and monitoring
- Provision of infrastructure for production and marketing
- Determination of levies and issue permits
- Serve as one stop centre to facilitate investment and ease the burden on the investors by liaising with other public agencies in securing the required licenses and permits for Aquaculture Parks investment and development
- Serve as a registry for aquaculture investors and entrepreneurs
- Secretariat and Membership of National Aquaculture Parks Committee

Role of District Government

The District Government shall be responsible for the following:

- Collection of levies and issue permits within the Aquaculture Parks governed by the agreed upon management strategies.
- Deliver public sector support and guidance to AP farmers.
- Register producers and ensure that they take a mandatory training in management and utilization of Aquaculture Parks prior to being considered for user rights in the Aquaculture Parks as leases
- Supervision and monitoring of production on the park (fish inspection of quantity and quality)
- Secretariat and Membership of Regional Aquaculture Parks Committee

Role of the private sector

- Investment in Aquaculture Park to an agreed minimum level (small scale farm)
- Undertake all training required by the AP.
- Commitment to produce in line with Good Management Practice
- Participation in AP Management Committee

Socio economic impacts and benefits

The scale of the Aquaculture Parks and the multiple enterprises they contain result in the AP developing into a significant local employment hub with 280 estimated for a cage-based park working at full capacity and nearly 400 jobs in a pond-based enterprise. There would be additional employment and wealth generated for nearby enterprises providing services to the AP as well as the wages spent in the local community.

Table 15 Estimated employment levels associated with each Aquaculture Park model

Type of employment	Cage-based park					Pond-based park				
	AP	Small (24)	Medium (12)	Large (1)	Total	AP	Small (19)	Medium (17)	Large (1)	Total
Management	4			1	5	2			1	3
Skilled	5	1	2	2	55	4	1	2	2	59
Semi-skilled	6				6	7				7
Manual	10	1	12	36	214	14	4	12	36	330
Total	25	2	14	39	280	28	5	14	39	399

The main socio-economic benefits that are likely to be derived from the establishment of Aquaculture Parks are:

- Production units provide gainful employment to both owners and employees (see Table 15).
- Rural development. The Aquaculture Parks will result in a population who will require additional services such as accommodation for families, schools, etc. leading to the development of towns.
- A significant increase in farmed fish production (wealth and nutritional benefits).
- Promotion of commercial aquaculture in the vicinity of the parks and across the country.
- Increased demand for commercial feeds in the country which will stimulate more investment in feed production and is likely to result in improved quality of feed produced.
- New markets and improved market access for farmed fish on the whole both locally and regionally because the volumes produced. The general population will become more familiar with farmed fish produces.

An example of the socio-economic benefits comes from the Mariculture Parks in the Philippines. These are found to provide economic benefits up to regional or inter-regional level. It was estimated that for every person in direct employment in the Park, there were 1.4 person equivalents also employed.

Some producers purchase their fingerlings for stocking/from regionally based in hatcheries. Feed manufacturers/millers from other regions regularly supply feed to the Park. Fish are sold to local plantation workers as well as local and regional markets.

In local communities, the effects and impacts of the Aquaculture Park's are considerable, due largely to incremental employment. A large number are employed as caretakers of privately-owned cage operators. Indirect positive effects and impacts also spread peripherally around these communities through increasing volumes and values of purchases from small-medium stores including additional incomes that went to entertainment and leisure where Park workers have periodically visited.

There are also socio-economic benefits due to the Parks increasing "*upstream activities*", e.g., fish fry producers, nursery operators, feed suppliers/agents and at the same with those in

"*downstream activities*" like processors of fish and other aquatic products, ice sellers and fish traders. Additional beneficiaries come from within the communities' periphery who engaged themselves into small-medium businesses.

9 Sustainability

Environmental Management

Carrying capacity estimation for Aquaculture Park zone
The estimation of the production carrying capacity of the Aquaculture Park should be integral to the development and site selection process for aquaculture activities to ensure the sustainability of the aquaculture production. There are a number of models that can be used that will predict environmental impact based on production and local environmental conditions.

Environmental Impact Assessment (EIA)
An EIA should be undertaken for the Aquaculture Park zone to determine the possible environmental impacts of a proposed project and identify measures to mitigate their effects. Mitigation refers to the reduction or removal of environmental effects/impacts of a project.

Mitigation measures are most successful when they are considered from the outset of the project rather than as a late stage solution to an identified problem. This can allow the design of the facility to include solutions to potential environmental problems rather than finding a solution, which fits with the design.

The EIA should then be followed by an environmental audit within a period of not less than twelve months and not more than thirty six months after the completion of the project or the commencement of its operations, whichever is earlier.

Environmental Management Plan
An Environmental Management Plan (EMP) should be drafted following the EIA.
The EMP should detail how the mitigation measures will be applied during the setting up and operation of the farm. It should define the operational procedures (including monitoring described below) to apply best management practice and identify contingencies should signs of environmental stress (poor water quality or disease) be identified within or outside the park.

Regular Environmental monitoring
The Environmental monitoring programme uses sampling of a defined number of parameters to highlight the extent to which aquaculture management affects the ecosystem over time, by comparing current data collected at various points in time with data obtained before development.

The monitoring protocol proposes what type of indicators should be used to monitor the impact of the farm at various points in time. It usually focuses on environmental parameters such as water effluent quality sediment quality under cages or close to effluent discharge.

The Aquaculture Park should undertake environmental monitoring external to the park on an annual basis.
This is in addition to (and not to be confused with) the water quality monitoring to be conducted on a daily basis within the park.

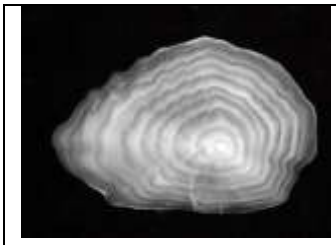
Synergies and compatibility for utilizing waste water for irrigation purposes specific to river fed, pond based system.
Effluent water from aquaculture ponds have relatively high organic nutrient loadings. Therefore effluents from the ponds should be made available for irrigation of crops in adjacent fields to allow recapture of the nutrients by plants before draining back into the river or lake. In addition, pond sediment should be made available for neighbouring farms and plantations.

Other Sustainability Issues

Distinguishing farmed and wild Tilapia
There are size limits on the mesh size that fishermen can use to catch wild Tilapia resulting in only larger Tilapia being caught (>500g). This may cause problems in distinguishing smaller farmed Tilapia and small illegally caught wild Tilapia especially at the lake based Aquaculture park where fish will be landed by both fishermen and aquaculture farmers at the same fish landing site.

There will be a strict chain of control for tilapia harvested from the fish farm to the marketing hall so that large Tilapia can be proven to be farmed. In addition, this problem could be solved by dipping all farmed Tilapia at the nursery stage in a solution of Alizarin dye for a period of 20 seconds. This dye is taken up by the otolith of the fish to create a distinctive red ring on the otolith that can easily be identified by fish inspectors at the market.

Figure 25. An unstained otolith, stained with alarzarin red and extracting an otolith

		
Unstained otolith	Red dye on otolith of tagged fish	Extracting an otolith

Good Aquaculture Practice and Standards
As the aquaculture industry expands so does its footprint on the environment and society. For a sustainable future, it is crucial to minimise potentially negative impacts: precious aquatic environments, reducing water pollution, eliminating inappropriate use of antibiotics, as well as to encourage the adoption of internationally acceptable social standards. These measures can be applied through farmers following Good Aquaculture Practice or more formally through an audited set of standards to ensure responsible aquaculture.

The Park should aspire to get all farmers to follow GAP and eventually for the Aquaculture Park to be accredited to an internationally recognised standards such as the ASC Tilapia standard.

These practices and standards typically cover;

- Escape and native species
- Predator control
- Water pollution
- Wetland conversion
- Land and water use
- Genetics
- Mortality
- Antibiotics
- Disease transfer
- Feed management
- Animal welfare
- Sanitation and waste disposal
- Labour and local community relations

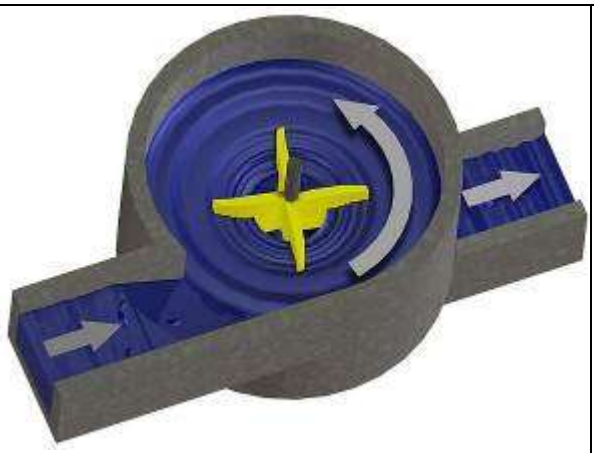
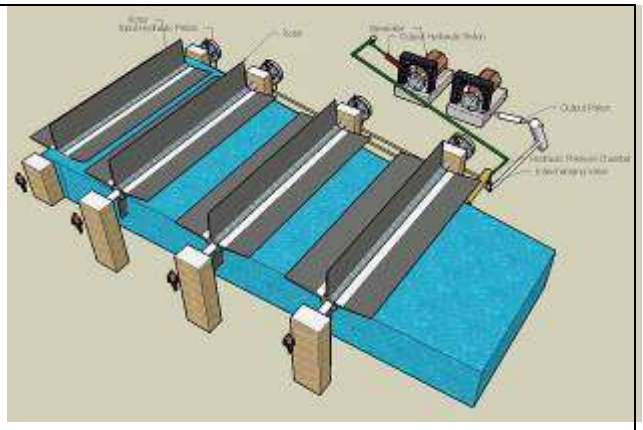
- Resource conflict
- Legal compliance

Green energy generation using Run of the River Hydro plants

There is a possibility for the reduction of diesel and electricity costs with the generation of electricity from the river flow. Run-of-the-river ROR) hydroelectricity is ideal for electricity generation from streams or rivers with a continuous water flow. ROR projects are dramatically different in design and appearance from conventional hydroelectric projects as the normal course of the river is not materially altered.

A hydro-electric power generation utilising the run of the river flows for generation of power with river flow for meeting diurnal or weekly fluctuations of demand.

Figure 26: Operating principles for Run of the River hydro electricity generating plants

	
Operating principle	Operating principle

Small-scale hydropower is one of the most cost-effective and reliable energy technologies to be considered for providing clean electricity generation.

In particular, the key advantages that small hydro has over wind, wave and solar power are:

- A high efficiency (70 - 90%), by far the best of all energy technologies.
- A high capacity factor (typically >50%), compared with 10% for solar and 30% for wind.
- A high level of predictability, varying with annual rainfall patterns.
- Slow rate of change; the output power varies only gradually from day to day (not from minute to minute).
- It is a long-lasting and robust technology; systems can readily be engineered to last for 50 years or more.

10 Risks and key mitigating strategies

There are a number of risks to aquaculture, which are identified below along with proposals to mitigate these risks.

Climate Change

Aquaculture development in Uganda is particularly vulnerable to climate change and climate variability, including extreme climatic events such as drought and flooding, due to seasonal water supplies. According to the Fourth Intergovernmental Panel on Climate Change Assessment Report, the global climate change models project an increase in average temperatures in Uganda by up to 1.5ºC in the next 20 years and by up to 4.3ºC by the 2080's.

Changes in rainfall patterns and total annual rainfall amounts with an increase in rainfall of 10 – 20% over most of the country with a decrease expected over the semiarid cattle corridor.
10 to 20% increase in runoff under future climate change scenarios for most of Uganda.
changes in the frequency or severity of extreme climate events such as droughts, floods and storms

Recent recorded rainfall data indicate some significant variations and changes in various parts of the country.

The mitigation measures that will be taken include:

- High perimeter dykes to prevent flooding within the Aquaculture Parks from the outside
- Siting cages in a sheltered area (enclosed bay or protected by Islands.

Biosecurity.

There is a risk of disease outbreak in the Park. Therefore, the biosecurity within the Park should be well managed. These measures should include

- All fry should be supplied from the AP hatchery
- All nets should be cleaned and dried after harvesting and before restocking with new fry
- All ponds should be emptied and dried after harvesting to reduce disease and eliminate predators.
- All vehicles entering the Park site should pass through a wheel disinfection trough
- No vehicles from other farms should enter beyond the marketing area.
- There should be coordinated treatment of fish in ponds or cages

Aquaculture Park zones should be separated from each other by at least 1 km to reduce the risk of transfer of disease between AP zones.

Security

There is a risk of theft of fish from cages and ponds. Therefore there will be strong security in the Park. Security should comprise of:

- Guard house at the entrance to the park or landing site manned 24 hours per day
- Security posts located at strategic points around the park manned at night
- Landing site and ponds fences with barbed wire.

Floating aquatic plants

Floating aquatic plants (comprising of floating papyrus and/or water hyacinth mats**)** can cause a threat to both land based Aquaculture Parks through the potential to block inlet pipes to the pump house and to lake based Aquaculture Parks through surrounding of the cages and reducing oxygen levels at night and restricting water flow.

	
Water hyacinth in Lake Victoria	Sudds in Lake Kyoga

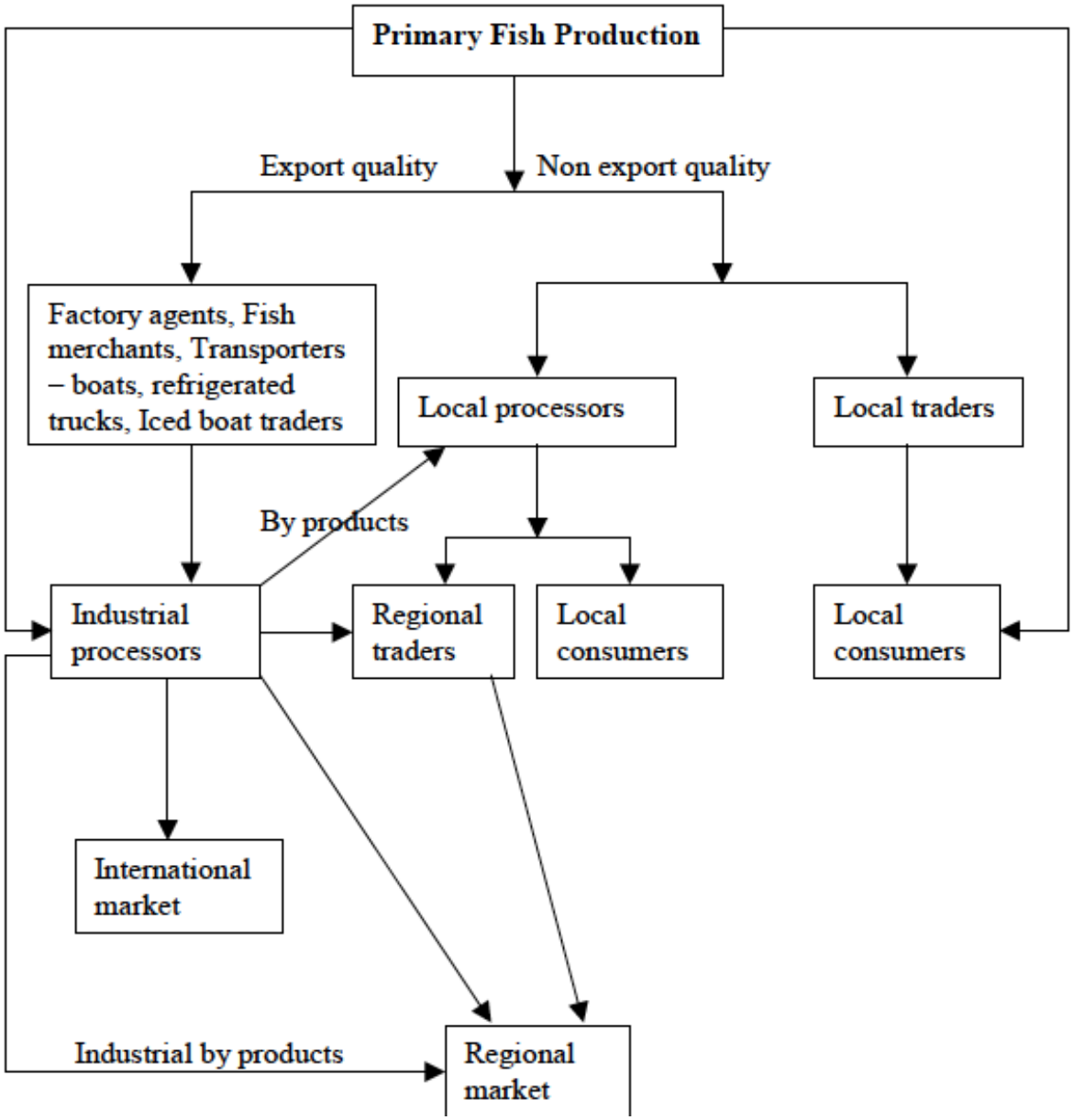
Design of the water intake should take this into consideration as well as regular collection of floating hyacinth around the cages.

11 Markets and marketing

Sensitivity analysis illustrates that fish price is a critical variable for the viability of the Aquaculture Park and its associated farm businesses. With the Aquaculture Park creating benefits in fish quality (through improved seed and feed inputs, as well as harvest and post-harvest handling & marketing), it is expected that better than average prices can be achieved by the Aquaculture Park. However, a conservative price point has been used which reflects current average farm-gate prices in Uganda.

Below we propose a recommended market approach, following an assessment of the local, regional and export markets for Ugandan tilapia and catfish illustrated in Figure 27.

Figure 27 Uganda fish market structure



source: Nyombi & Bolwig, 2004

Local Markets

The local market is defined as the Ugandan domestic market, where variations in market preferences can be identified across Uganda's regions:

- The North of Uganda, East of Nile traditionally favours catfish
- To the West, local markets favour Tilapia
- In the arid cattle corridor, the Bahiima are the major cattle tribe in the cattle corridor and have no tradition for fish consumption
- In the urban areas of Kampala/Entebbe there is a mix of preferences; the younger generation prefer tilapia & nile perch, while the older generation likes catfish.
- There is a growing market for added value products such as fish burgers, coming from the Nile perch processors and new products such as fish sausages made from catfish.

Excepting areas where there is no culture of fish consumption, local markets are strong. The price of fish is on a par with many meats, being driven by the prices being paid by regional traders. With the recent downturn in wild catches, the demand for farmed fish from regional and local markets has increased.

The preference for wild fish in the local market remains, where size is the primary determinant of price. Perceptions and buying patterns are, however, changing with fish consumption in the food service sector now favouring the consistent supply and quality of farmed fish.

Farmers are known to sell their tilapia and catfish to individual consumers at the farm gate. Some also do some added value of smoking catfish. There is anecdotal evidence of very small tilapia (100-200g) being sold direct into the local market by farmers.

Regional markets

The regional market is defined as Eastern and Central Africa. The coastal nation of Tanzania is less dependent on imports from other EAC members with its access to marine and Lake Victoria resources as well as imports arriving by sea. However a network of traders operating across the region is servicing the growing demand for fish from land-locked African nations.

Regional traders visit producers and landing sites throughout Uganda. Most will attend farm sites such as SoN and landing sites on a weekly basis, buying the catch or harvest directly from fishermen/farmers and loading it onto trucks (boxing the fish with ice). Producers report 1-3 buyers arriving per day, following telephone contact to be certain that some fish will be available for sale to them.

The following regional preferences are noted:

- The DRC traders take tilapia and catfish;
- Sudan takes tilapia and catfish;
- Rwanda preference for tilapia;
- Kenya has a preference for tilapia (and catfish in western region).

The regional market has been growing in recent years with stability in the region enabling trade growth. This is particularly true for the newly-constituted South Sudan, which was given substantial financial support to become established. This has had an impact on the regional fish market as visiting Sudanese traders buy-up as much as they can. Consequently prices are good; far better in fact than the export market on which the Nile perch sector based itself. As export prices slumped to 3,500 for N. perch (see below), regional traders continue to pay double this price.
The largest tilapia in Uganda, Source of the Nile, does not distribute its production, but sells direct to regional traders coming to the farm. There is little incentive to develop its own distribution with the strong demand and good prices offered by customers coming to them.

Despite the comparatively good prices, producers are conscious of the high retail prices for their products; 350-500g tilapia sell for 6,000 USH/kg at first hand sale price, but retail for 11,000 USh/kg. While the margin is substantial, transport costs in Uganda are high. Poor roads in rural areas where most of the farms and landing sites are based, coupled with high fuel costs, makes such a margin understandable.

Over time, the AP could develop an efficient cold chain that could distribute product to its key markets in a more efficient manner than the individual regional traders. This should enable the Aquaculture Park to undercut the margin currently applied to farm-gate prices by traders.

Export markets

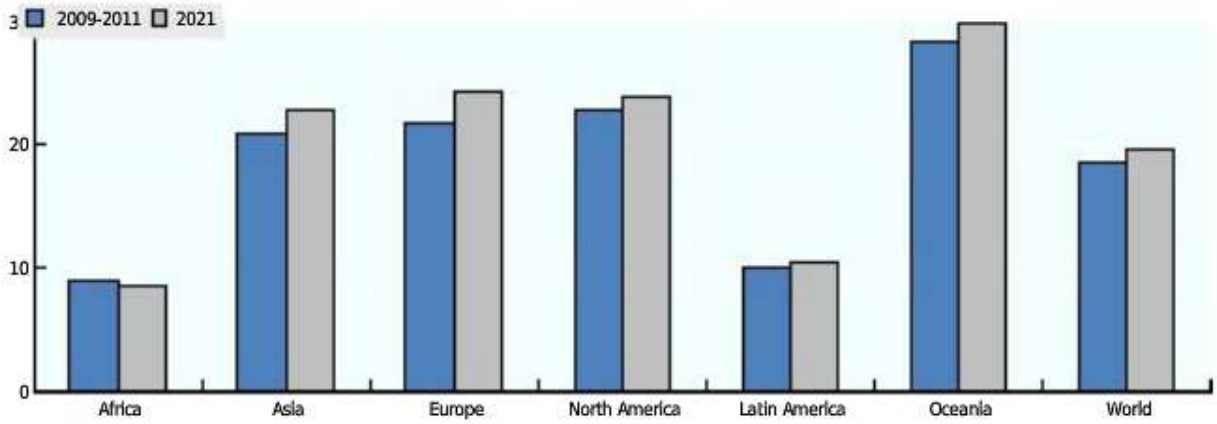
The Nile perch industry has developed as an export-orientated business. This was highly successful for many years, but a number of factors has resulted in a major downturn in fortunes; the loss of European market share to Panagasius from Vietnam and the Eurozone crisis have both slashed the price processors are willing to buy at down from around 10,000USH/kg to 3,500USH/kg.

Recent wild catches from Lake Victoria (and other water bodies) have declined substantially, resulting in the processing sector only operating at an estimated 20-25% capacity. The processing sector is therefore seeking additional raw material supplies, presenting another market opportunity for the AP. However, as the best prices would be achieved for fresh, whole fish it is unlikely that the processing sector would be a major market for the premium-quality Aquaculture Park fish.

Market potential

Estimates of Uganda's annual per capita fish consumption vary from around 12.5kg (Jagger & Pender, 2001), while the Ugandan Household Survey puts it at around 7kg/capita/yr. This is well below the global average of 17kg/capita/yr. A recent OECD-FAO forecast expected fish consumption to rise for every continent other than Africa where a drop from 9kg to 8.6 is predicted. This is mainly due to the continued decline in per capita fish supply as many wild capture fisheries become overfished.

Figure 28 Estimated fish consumption per capita by continent, 2009-11 & 2021



source: OECD Agricultural Outlook, 2012

While consumption and supply are decreasing, the demand for fish in Uganda, as elsewhere in the region has increased with population and GDP growth. It is the availability and affordability of fish that is preventing the increases in fish consumption even to FAO recommended minimum levels. Export strategies that target markets on other continents can pose a real threat to domestic food security. Additionally, as described above, many export markets do not present such an attractive economic proposition in the current economic crisis.

Developing countries as a whole are projected to continue to be net fish exporters in 2020, but sub-Saharan Africa's current fish trade deficit is expected to worsen 9-fold, increasing from 54 thousand metric tonnes in 1997 to 492 thousand metric tonnes in 2020 (Delgado et al. 2003).

For the domestic and regional markets, a simple calculation illustrates the scale of the market. At the African average of 9kg per fish per capita and 2012 population levels of Uganda (32 million), DRC (69.5 million), Sudan (45.7 million), Rwanda (11.2million) and Kenya (42.7million), total fish consumption in these key markets amounts to 1.8 million tonnes of fish. Even a minor increase to FAO minimum recommended consumption levels would require nearly 200,000 tonnes more fish into regional markets.

Most current supplies are imported from elsewhere in the region or from overseas and by necessity these are often in processed form. The supply of good quality fresh chilled fish into these markets is limited, indicating a clear competitive advantage of the Aquaculture Park in these regional markets.

The market potential for Ugandan fish within central and Eastern Africa is huge as domestic and regional consumption can increase from relatively low levels and a greater domestic supply can provide some counterbalance to the fish trade deficit.

The ambitious expansion plans of Lake Harvest and SoN illustrate that commercial operators see significant potential for tilapia in the East/Central African market.

Supplies from Aquaculture Parks will not have an adverse impact on prices or supplies as:

- There is growing demand for fish, particularly high-quality fish in urban markets, that is not matched by supply;
- There are large variations in market supply due to fluctuations in the wild catch; and
- Aquaculture Park supply will be managed by the park service company to ensure a steady supply of product into the market.

Other aspects of competition are explored below.

Competition & competitiveness

The earlier study (Poseidon, 2011) stressed the importance of the market in a sustainable and viable commercial aquaculture sector with the main market-related problems identified as:

- Low production volumes, limiting the ability of fish farms to influence the market. Fish farmers need to be able to supply reliable and sufficient quantities to access markets.
- There is no marketing organisation for aquaculture produce that could increase market power, and generate efficiencies/savings in transportation costs.
- Existing market infrastructure is set up for wild catches. Fish farmers need collection centres, live holding facilities, vans, market stalls etc. for farmed fish. Fish farmers also need access to live fish transportation equipment for both table fish and fingerlings.
- There is poor post-harvest handling and quality maintenance during distribution.
- A lack of product differentiation with wild fish
- Access to regional markets for small scale producers.

The proposed operation and marketing of Aquaculture Parks will address many of these barriers through creating a critical mass of production and having the management and infrastructure to better control market supply and quality. It is therefore expected that operators within Aquaculture Parks will enjoy a number of competitive advantages compared to other producers in the region.

The Aquaculture Park production assumptions used for FCR, cost of production, etc. are based on international industry norms for good practice, rather than average performance in Uganda as currently Ugandan producers are constrained by costly supplies of feed and seed of variable quality. Many also lack the technical support to achieve optimal production. The Aquaculture Park would address this with tighter control on inputs and extension services supplying the technical support to ensure all producers have the potential to achieve good practice. It is in the AP service company's interest to ensure park producers are operating good practice as this better ensures supplies, reduces the risk of disease outbreak and its profitable tenants are more likely to continue in operation.

Marketing by the Aquaculture Park would ensure that there are not market conflicts or competition between AP producers. Similarly the proposed regional co-ordination of Aquaculture Parks should aim to minimise future competition between Aquaculture Parks.

The collective scale of production will also enable small scale producers within the Aquaculture Park to access the better prices found in regional markets that could not be accessed previously as small production volumes would not attract regional traders.

The above aspects would put Aquaculture Park tenants (and potentially even surrounding producers) at a competitive advantage to other farmers in the region operating in isolation. However, the collective marketing of production through the Aquaculture Park service company is expected to avoid AP production negatively impacting prices in local and regional markets for other producers. It is also expected that the quality assurance and scale of production from the AP will mostly supply large volume supply chains servicing urban markets and regional distribution hubs, rather than existing local supply chains where the market could be over-supplied by AP production.

Previously Ugandans would prefer wild fish and it continues to be the case that larger fish command a higher per kilo price. However the comparatively poor perception of farmed fish is changing. Those producing poor quality fish (with low quality seed and feed) drop out of the sector. Aq-

uaculture operators are able to provide consistency of supply, which is so important to markets. African urban markets increasingly demand higher-quality fish products and this can be better guaranteed with supply from good farms.

Regional traders and Ugandan wholesale buyers in many cases now prefer farmed supplies as consistency in size and quality can be assured. The collection at farm gate point of harvest onto ice better ensures high quality compared to variable wild supplies at landing sites. Overall therefore the competitive position of farmed fish in the Ugandan and regional market is strong compared to wild fish.

Aquaculture Park fish would also be well placed in relation to other farmed fish as the organisation is able to control the quality of seed, feed and water as well as promote grower standards for all fish produced on the park. This assurance of high quality should be communicated to buyers and potentially even consumers via branding (see section below). The scale of production is such that regional traders would be more likely to visit the Aquaculture Park on a regular basis than other suppliers. With regular collection of substantial volumes at a known point, traders can achieve transport efficiencies in the supply chain. These aspects suggest the AP fish could command a price premium in the market. The economic feasibility is, however, based on current market prices for the given size grades.

There is only one Ugandan tilapia producer of a scale close to that planned in the Aquaculture Park, Source of Nile, which has expansion plans from its current 4-500t level towards 1,000t/yr. The size of the regional market means that this producer would not be adversely impacted by the introduction of an Aquaculture Park and it could be mutually beneficial for that these successful commercial operators be directly involved in its development.

Recommended Market approach

Objective

An overarching objective of the project is to increase per capita consumption of fish to FAO recommended levels. Therefore growing the Ugandan market for farmed fish should form a part of any market strategy. This should be very achievable given the reduced wild fish landings and the ability to shorten the supply chain that can reduce the retail price of fish (without reducing farm gate price).

To achieve the development goals intended, it must also clearly be an objective that the Aquaculture Park and its tenants are profitable. Therefore it is proposed that regional markets are the initial target for Aquaculture Park production as these markets can easily absorb large volumes straight away at good prices.

The Aquaculture Park Investment policy states the marketing objective is (3.5): *"Ensuring the production, handling, processing and associated cold chain that is linked to specific markets. Co-operative marketing shall be done around producer organisations and groups for small holder based AP's which shall link the small scale farmers to markets to avoid exploitation."*

Approach

It is proposed that the Aquaculture Park Company will manage the marketing of the product. This will be steered by a management committee, which has strong farmer and/or farmer co-operative membership. The intention is to ensure efficiency and transparency in the service provided. In this way farmers can benefit from the larger scale of production and marketing expertise of a larger organisation, without feeling they are simply contract growers. The farmers should feel that the Aquaculture Park is working for them, not the other way around, as it is their company.

Consultation with stakeholders has identified that producers would not appreciate being forced to sell to the AP and should therefore be free to seek and respond to better prices. It is therefore proposed that farmers be free to sell to anyone they choose. However, to ensure consistent quality from the AP and that any AP charges and repayments are paid by the producers, it is proposed that the actual supply to farmer customers is still via the AP company. In this way, harvesting levels (to manage supply to the market) & quality can be controlled.

Organisation

Marketing is managed by the Aquaculture Park (with joint planning by the Growers Committee/Co-operative). The timing of harvesting will be in line with a production plan that determines when each pond is stocked and harvested. Ponds will be stocked sequentially to ensure a consistent supply of product and that farmers are able to benefit from regular harvesting of their ponds to aid cashflow.

As the plan is for full harvesting of ponds, a range of sizes will be harvested. A diverse customer base should be developed: local markets where a range of fish sizes can be accommodated, and regional wholesalers and processors seeking consistent size.

Quality will be assured on all outputs from the AP through tight control of harvest procedures and post-harvest handling in temperature controlled and hygienic conditions. The AP is the start of the cold chain and this will link to cold chain distribution, which may either be the company's own or in collaboration with another company.

Branding

Initially the Aquaculture Park is expected to supply the buoyant regional markets, selling to existing regional traders that are currently purchasing from multiple producers throughout Uganda. The Aquaculture Park would become a district trading hub as regional traders that previously had to travel long distances to collect sufficient supplies via multiple farms would only have to visit the AP. The economic analysis is based on current prices, but the Aquaculture Park could potentially command a higher price with the consistent supply of high quality fish at one location. The high production standards proposed for the park presents the opportunity to develop a high quality brand for Aquaculture Park fish.

Although the regional market for whole, chilled fish is proposed as the main focus of marketing initially, other market opportunities should be explored. The Aquaculture Park should manage production to ensure that nothing is considered as 'surplus'. With control over production and supply, the Aquaculture Park company will quickly experience how much can enter the regional market before prices are affected. However, market demand can change and therefore there may be a need for the processing sector to take some of the larger sizes for filleting. There is also growing demand for value-

added products, particularly for catfish, which may indicate that linkage with the processors would be advantageous. The need for a lead-in time to establish production lines suggests that this option should be explored by the Aquaculture Park through discussions with the processing sector.

Wider efforts should be applied to develop the Ugandan market for farmed tilapia and catfish. Such efforts may include market promotions and awareness-raising to explain the benefits (nutritional and environmental) of Aquaculture Park farmed fish. This can be part of the generic promotion of farmed fish, under the supervision of a sector-wide development body (similar to the DDA described in the box above) and through AP-specific branding.

To ensure farmers outside of the Aquaculture Park are not disadvantaged, arrangements could be made for fish from outside of the Aquaculture Park to be sold through its marketing channel as long as its quality standards are met.

Box 1 Ugandan Dairy Sector - example of established cold chain

The dairy sector is considered to be the most organized livestock sub-sector in Uganda. Currently, the Dairy Development Authority (DDA) is charged with promoting production, competition and monitoring the markets for milk and dairy products. To achieve this, DDA collaborates closely with multiple private sector organizations operating in Uganda (IGAD, 2008). The Dairy Development Authority (established in June 2000) performs regulatory and dairy development services for stake-holders in the dairy sector. There are a total of 11 unions and 378 dairy cooperatives, registered by the Office of Registrar of Cooperatives, in the six milk sheds increasing market access for small-holder and commercial dairy farmers.

About 628 milk coolers have been installed for milk bulking and milk retailing across the country. Raw milk is transported by insulated milk road tankers from the bulking centers to processing plants and other urban milk retailing outlets to ensure that the cold chain is maintained. Currently there are 126 insulated milk road tankers with a capacity of 876,850 litres inspected and certified by DDA. The DDA also provided training to dairy operators and to improve access to markets by rural dairy farmers, twelve farmer marketing groups were provided with milk chilling plants and linked to for-mal markets.

There are also lessons to be learned from the dairy sector increasing consumption in Uganda. Alt-hough the per capita consumption of milk (kg/year) has increased over the last ten years from 40 litres per annum in 2001 to 50 litres as of 2009, it is still below the WHO recommended 200 litres per annum. DDA is carrying out generic promotion campaigns to increase milk consumption in Uganda and is currently targeting the school children under the New School Milk Programme. The program promotes the distribution of both fresh and UHT milk to primary school children ages 6 to 13 years and targets over 3 million children in over 100 schools piloting in Kampala. These promo-tional efforts need to be in combination with the AP to ensure the creation of demand is supported by sufficient supply.

Source: DDA Profile for EAC Yearbook

12 Funding options

The National Aquaculture Parks Investment Policy, drafted by the Aquaculture Policy Working Group (APWG) of the Parliamentary Investment Round Table (PIRT), sets the policy context for this feasibility study and states that financing will be guided by the following principles:

- Private sector will fund the aquaculture production, business operations and marketing activities while the public sector shall finance the establishment and servicing of Aquaculture Parks, incubation of aquaculture enterprises through equity funding and capacity building, and institutional development.
- Ensuring financing of the most critical policy areas of access to appropriate production technology, aquaculture inputs, technical services and business management
- Provision of public and donor equity funding and investment support to meet set production targets
- Public and donor support to affirmative action to ensure gender and economic equity and balance in aquaculture development
- Mainstreaming environmental responsibility in aquaculture production and promotion of good aquaculture governance
- Public and donor funding to private sector financing institutions so as to guarantee associated risks in aquaculture production especially for smallholder producers and enterprises
- Streamlining and aligning development financing project support to aquaculture development to allow for effective cooperation and collaboration between the different public and donor supported funding agencies and projects.

This section explores the potential funding options and areas of support for a Ugandan Aquaculture Park. There are two areas to consider: (i) funding to establish the Aquaculture Park and (ii) funding for small-scale farmers to invest in the park.

Funding to establish the Aquaculture Park

A number of potential funding sources for the Aquaculture Parks are considered below.

Public Private Partnership

A recent FAO publication on Agricultural Investment Funds identified that PPPs can be a valuable tool to increase access to finance for the agricultural sector. Due to the specific characteristics and risks related to this sector, public capital can be important in attracting private investors who otherwise would not be willing to take an exposure to agriculture. By doing so, public funds might allow private investors to acquaint themselves with the sector with the aim of possibly withdrawing public money in the future (Agricultural Investment Funds for Developing Countries, FAO, 2010).

The preferred approach to the development of Aquaculture Parks in Uganda is via a public-private partnership (PPP). This is to be achieved by establishing an Aquaculture Park company for the pilot site where a range of investment scales is possible and through seeking a large-scale private sector partner to invest in the Aquaculture Park.

A PPP should provide benefits to both parties: the public sector ensures some of the capital costs of the development are met by the private sector, while for the private investor the AP should represent a lower cost investment with shared infrastructure and a lower risk investment with facilitation by the public sector in terms of permitting. There is currently only one relatively large-scale aquaculture producer in Uganda; Source of the Nile, with investment from the Zimbabwe-based Lake Harvest, the largest tilapia producer in Africa. Source of the Nile is known to be expanding its operations in Uganda and is an obvious potential partner for the Aquaculture Park pilot. However, there are also upstream and downstream commercial operators in the fisheries sector in Uganda, such as the members of the Uganda Fish processors & Exporters Association (some of whom also have aquaculture interests) and the feed manufacturer, Ugachick. These companies have the benefit of direct experience of Uganda's fisheries sector and existing supply chains and links that the AP could benefit from (sourcing supplies and marketing its production).

There are non-fisheries companies that may have an interest in Aquaculture Parks as it presents a route into aquaculture, a sector that has been identified as having significant potential in Uganda, with a substantial amount of technical assistance proposed. Large agri-industrial companies such as Mukwano (vegetable oil) and Bidco (palm oil) have existing operations and infrastructure in the areas being considered. These companies already operate nucleus estate and outgrower schemes that have a number of similarities with the AP concept. There may also be meat and dairy companies, such as Sameer Agriculture and Livestock Ltd (SALL), that are seeking to diversify into fish products (potentially with existing cold chain distribution infrastructure in place). These companies would bring a substantial amount of commercial (Ugandan) experience in production systems, marketing and distribution. As with the proposed small-scale farmer investors, large-scale investors with little or no experience in aquaculture must be supported by substantial long-term technical assistance involving those with direct operational experience of Aquaculture Parks in other countries.

There is already overseas interest in Uganda's potential for aquaculture and the Aquaculture Park pilot would present a low risk opportunity for a foreign investor to become involved in the sector, with many of the usual barriers to establishment such as site selection, land acquisition and permitting being wholly addressed or at least facilitated by the Government of Uganda. China, the largest tilapia producer in the world, has established links and provided substantial support at NaFIRRI's aquaculture research station in Kajansi. These contacts would be able to discuss the potential involvement and provide introductions to Chinese tilapia producers such as Gunagdong Evergreen and Guolian. Similarly, Norway has global expertise in fish farming and Norad is already providing similar support to forestry development with the Sawlog project.

The involvement of a variety of developing country public sector and private sector entities is key to building the institutional framework that will provide a market-friendly environment that investors,

particularly the private sector ones, require. In this sense, the various ministries of agriculture, trade, planning and the prime ministers' offices need to seek advice from the local entrepreneurs and also communicate directly with international private sector institutional investors (FAO, 2010).

It is recommended that MAAIF work with the Ugandan Investment Authority (UIA) to develop a prospectus to inform & target potential Aquaculture Park investors both within Uganda and overseas.

Equity Fund.

An Equity Fund could provide direct investment in the Aquaculture Park company. This would require clear evidence of expected good financial returns in the medium term (10 years). The difference in this form of investment to others proposed for the AP is that the fund would provide investment capital without itself committing to delivering production in the park. A minimum amount of production is required to achieve the break-even level and therefore Equity funding can only be part of a mix of funding, alongside farmer investment to help establish the park.

The consultants have discussed the potential for involvement of the EU Equity Fund with the EU delegation. There appears to be a good fit between the AP targets and the objectives of the EU equity fund, namely socio-economic benefits in Uganda with financial returns. The fund is to support existing SMEs seeking to expand in any part of the agri-food sector, but not existing larger companies or start-up companies. The AP company would be new, but would have a number of existing operators involved and therefore may still quality under the fund. However, the fund is yet to be established and the précised details regarding investment criteria are unknown.

The economic analysis shows that there is a balance to be struck between the profitability of the farmers and that of the Aquaculture Park company. As shareholders in the company, the farmers would benefit from company profits, but this cannot be to the detriment of the farmers individual businesses. Aquaculture Park profit levels are therefore constrained to ensure farmer profitability, at least in the early years of establishing the AP. There will also be a period where part or all of the capital costs of park establishment (which is likely to be on a phased approach) must be repaid by the Aquaculture Park company.

Repayment of financing options

The returns estimated in the balance sheets (Annex 9) illustrate that the AP company should provide good levels of return in the medium to long term. These assume that the cage and pond APs build up to full production of 3,000t and 2,400t respectively within 5 years. Break-even points for the AP company are 600t for the cage-based model and 1,120t for the pond-based model. This indicates that optimal development would require a large-scale producer, which could be either from a private company investing in the park or using the nucleus estate model where the private sector runs production on behalf of the public sector.

The balance sheets for the farms include the cost of borrowing to account for the need for each to invest in the AP. These show that with profitable farming operations the farmers are able to repay their investments over 5 years.

The balance sheets for the AP suggest an operating profit in year 3 as production levels increase above break-even points. This presents the opportunity of providing some returns to investors from year 3 onwards. The amount returned should be determined by the board of directors (which may be influenced by expected returns of external funding sources), but a return of 50% of profits to investors is assumed. For the model cage AP this level of return would pay back the initial investment levels in 12 years, but for the Mwena site with lower capital costs, the lower level of investment would be repaid in 10 years. The higher capital costs and so assumed investment in the pond-based AP model results in repayment after 13 years for the medium and large scale investor, and 19 years for small scale investors.

Funding to small scale investors

Scale of Investment

The proposed business model assumes that capital costs are to be recovered. Cost recovery will be through the purchase of shares in the service company and the profits from the service company. The balance between these two revenue streams will depend on the share price set and the allocation of profits by the service company.

As the intention is to encourage small and medium farmers to invest in the farm, the share price (equating to the allocation of cages) must be at realistic levels.

The estimated capital cost of the Model Cage Park is 8.27bn USH, which equates to 83,000USH per m3 of production (totalling 99,510 m3)

To recover 100% of the capital costs via shares, the investment cost per cage for the small-scale farmers is estimated at around 600,000USH per small cage (totalling 16million USH for a small farm of 25 small cages). For the medium scale farmers (operating the medium sized cages) investment equates to around 2millionUSH/cage, nearly 100million for a farm of 50 medium cages. This would be out of reach for the majority of small and medium scale farmers.

For the Mwena site where a number of savings have been identified using the existing landings site infrastructure, the total capital cost is reduced to an estimated 5.6bn USH, or 56,500USH per m3 of production area (totalling 99,510m3). To recover 100% of capital costs in proportion to production volume, small-scale investment would therefore be reduced to 425,000USH per cage or 11 million per farm of 25 small cages. This would still be out of reach for most small-scale farmers and therefore 50% capital cost recovery is assumed in the models.

With investment levels based on proportion of production volume, the 24 small-scale farmers contribute 4.5% of the capital costs, the 12 medium scale farmers provide 14% of capital costs and the large scale farmer over 80% of the capital cost. This makes the viability of the model entirely dependent on the presence of a large-scale investor. As described above, the pilot AP could become established on a nucleus estate model in the first instance prior to divestment to private sector.

To secure investment from small and medium scale farmers, the share offer can only attempt to recoup a proportion of the capital costs. The involvement of an equity fund could help to cover some of capital costs, but would not contribute to future production in the park. There must therefore be a balance between farmer investment and Equity Fund investment as the AP Lake Company depends on a minimum level of production (600t). The investment level (AP Company share price) should be set at a level that encourages investment by all types of investor. Estimates of loan amounts for small and medium scale investors based on discussions with the Centenary bank suggest the usual investment range for small scale farmers is 10 to 20 million USH, while this increases to 50-100 million USH for medium scale farmers. It is only recently that banks have begun lending to aquaculture ventures and therefore the involvement in the AP rather than as an isolated investment should provide some assurance to credit providers.

The sensitivity analysis illustrates that farmer profitability is tied to a minimum farm size (particularly small scale farmers). Therefore minimum investment will be based on what may be deemed a manageable number of farmers operating in the AP. At full capacity in the base case, 25 small cages per small scale farmer (half a string) and 50 medium cages per medium scale farmer (a full string) result in 24 small scale farmers and 12 medium scale farmers. This appears to be a manageable and well-balanced arrangement, but could be revised up or down.

Capital grants

A system of capital grants must encourage the development of profitable aquaculture businesses, not support businesses that would fail if they did not get grant support. The advantage of grants over other financial products is that they can easily be administered and disbursed during the timescale of a project. They can be very strong incentive for development by all types of investor – much stronger than access to loans. A grant system could be based on the positive experiences of the Sawlog Project (see box 2) but adapted to the particular circumstances of the commercial aquaculture industry. The basic principle under such a system would be that qualifying investors would be able to apply for grants to help them secure a lease in the AP, the main up-front cost for investors, and possibly assistance with seed stocking and feed costs ahead of returns from the first harvest (6-8 months).

Box 2 Sawlog Project

(www.sawlog.ug)
The Sawlog Production Grant Scheme (SPGS) funds the establishment of timber plantations. The project has been the catalyst for over US$20m of private sector investment into timber plantations in Uganda since 2004 and has provided training and technical assistance to over 300 individual investors. A grant is agreed with investors (around 850,000 per ha for small & medium scale investors, around half the estimated costs to establish and maintain a plantation), which is paid in installments when investors have undergone training and shown their application of good forestry practice in their plantations. All investors are at what is deemed a minimum commercial scale of 25ha or above. Larger commercial forestry investors are also encouraged through the scheme. The scheme has also recently expanded to involve institutions (woodlot) that have land and may use a lot of firewood.

Applications are sought via advertisements in relevant media; those applicants are required to submit a business plan (Forest Management Plan) and proof of land ownership. A technical committee reviews all applications and then an offer may be made following a site visit. A contract is signed with the ministry containing various terms and conditions the forester must adhere to.

To maintain the training and support after the project comes to an end, the Ugandan Timber Growers Association (UGTA, www.utga.ug) has been established. The UTGA provides technical support and sells seedlings to generate revenue. It has also set up a fund to support farmers hit by crisis such as fire or disease.
Source: Francis Ssaali, Plantation Officer, SPGS pers. Comm.

The use of capital grants may be an appropriate tool for the pilot Aquaculture Park to encourage (commercial) small-scale farmers to invest in what is a new concept for Uganda. However, with clear evidence of returns on investment there should be a move to reduced grants rates with the removal of this subsidy for future APs.

Loans

Commercial loans are becoming more available as Ugandan lending institutions learn about the aquaculture sector. Centenary Bank has recently started loaning to aquaculture inv and the Bank of Uganda has established an agri-food credit scheme. However, commercial interest rates are high; Centenary Bank quoted 22% plus a 6% monitoring charge to oversee the investment. These high interest rates are a substantial disincentive to potential investors. The AP should provide a greater level of assurance to lending institutions as technical assistance and the AP's own monitoring of all producers within the park will reduce the risk level compared to individual operators. This may therefore enable the monitoring charge to be negotiated down. However even removing the fee, 22% interest remains a substantial cost to investors. The economic analysis includes consideration of a small-scale farmer using commercial loan at 22% to fund his investment in the park. It shows that the monthly income dips below the USH1million target while the loan is being repaid over 5 years, but rises above this from year 6 onwards.

Credit is becoming more available to the agri-food sector with recent schemes announced by the Bank of Uganda and a USAID project working with the banking sector to illustrate the viability of aquaculture enterprises. The lending environment for aquaculture is therefore improving and with inflation reducing, the opportunity for small to medium scale farmers to invest in the AP is real.

Another alternative to commercial loans is for the Aquaculture Park itself to provide loans to producers within the park. These loans would be paid off with future production (sold to or via the AP). With the need to establish the company and fund the capital build costs, it is not envisaged that a loan facilities from the AP would be an initial option for investors, but the company could help to facilitate access to loans at preferential rates (as described above) and in future may have the financial resources to provide a loan service. The AP could however extend credit to farmers in the park for seed and feed, enabling them to stock their ponds and repay that credit upon harvest.

13 Legislation & Regulation

National Regulation and permitting related to Aquaculture Parks

The table below illustrates the numerous regulations that an Aquaculture Park must comply with. The need for numerous permits from various agencies is a barrier to development. MAAIF should drive the development of Aquaculture Parks and seek the necessary permits for the whole park, which will be a considerable advantage for producers within the park compared to attempting to establish a site as a single enterprise.

Table 16 Description of organisations involved with Aquaculture in Uganda

Organisation	Jurisdiction
NEMA	**MINIMUM STANDARDS FOR DISCHARGE OF EFFLUENTS INTO WATER OR LAND REGULATIONS.** These Regulations prohibit discharge of effluent or waste on land or into the aquatic environment contrary to established standards and without a **waste discharge permit**. They provide for the general obligation to mitigate pollution by installation of antipollution equipment for the treatment of effluent and waste discharge emanating from an industry or establishment. They also provide for sampling of effluent and waste water analysis. http://www.nemaug.org/regulations/effluent_discharge_regulations.pdf
	WETLANDS, RIVER BANKS AND LAKE SHORES MANAGEMENT REGULATIONS These Regulations provide for the protection of wetlands; their conservation and wise use; inventorying of wetlands; and wetland use permits for regulated activities. The Regulations also provide for **protection zones for riverbanks and lakeshores**. In particular, the rivers and lakes outlined in the sixth and seventh schedules to the Regulations have a protection zone of two hundred metres from the low water mark for lakes and one hundred meters from the highest water mark for rivers. Other lakes and rivers have a protection zone of one hundred metres from the low water mark for lakes and thirty metres from the highest water mark for rivers. No activity is permitted in the protection zone without the written authority of the executive director of the National Environment Management Authority. http://www.nemaug.org/regulations/wetlands_riverbanks.pdf
	THE NATIONAL ENVIRONMENT IMPACT ASSESSEMENT REGULATIONS, 1998. These Regulation deals with the environmental impact assessment (EIA) process, including project briefs and environmental impact studies. The Regulation provide for EIA review processes, including invitation of general public comments and public hearings, and the decision of the Executive Director of the National Environment Management Authority in respect of the grant, rejection or cancellation of an **EIA certificate**. http://www.nemaug.org/regulations/eia_egulations.pdf
	THE NATIONAL ENVIRONMENT WATER ACT The Water Act is one piece of Uganda's sectoral legislation with key provisions to enhance sustainable development. It provides for the use, protection and management of water use and supply. Important aspects in the Act include water rights; planning for water use; control on the use of water resources; water easements; and control over water works and water use. http://www.nemaug.org/regulations/water_act.pdf
Government of Uganda	**THE LAND ACT** This 1998 act provides for the tenure, ownership and management of land;

	and to provide for other related or incidental matters. It entails the land holding systems in Uganda, control of land use, management and tribunals as well as protection of bona fide occupants and land users. All transactions relating to acquisition and utilisation of public or private land are embodied in the act. http://www.ulii.org/ug/legislation/consolidated-act/227
	THE FISH (AQUACULTURE) RULES (2003) The rules provide for the approval of aquaculture establishments, provision of adequate measures for confinement, issuance and withdrawal of aquaculture permits for production, transport, breeding and marketing. The rules also detail the list of live fish species that can be exported out or imported into Uganda. Approved permits provide represent compliance.
	THE FOOD AND DRUGS ACT This protects consumers of food against adulteration of food and drugs and for matters incidental and connected to food and drug use. http://www.ulii.org/ug/legislation/consolidated-act/278
	THE WATER ACT The act provides for the use, protection and management of water supply, in addition to the constitution of water and sewerage authorities, and, the devolution of water supply and sewerage undertakings. It entails the rights in water and water administration; water resource planning; hydraulic works and use of water; revision, variation and the cancellation of water permits, as well as waste discharge permits. http://www.ulii.org/ug/legislation/consolidated-act/152
	THE NATIONAL ANIMAL FEEDS POLICY The fish feeds industry is regulated under this policy and its objectives include: - increasing feed production and availability -ensuring that consumers are protected against contaminated, poorly packaged and formulated feeds. -formulating strategies of production at minimal costs in order to ensure that producers' as well as consumer's interests with regard to prices and profits are catered for -building capacity in both the private and public sector for improvement in the industry. Under this policy, the private sector is encouraged to produce and market quality feeds; a conducive environment must be present for quality control and good manufacturing practice; a friendly fiscal and regulatory environment for the growth of the industry is ensured.
NDA	**THE NATIONAL DRUG POLICY AND AUTHORITY ACT**

	Drugs and hormone use in aquaculture detailed under this act of the Ugandan constitution. Its major role is in safeguarding the appropriate use of drugs and all related material. http://www.ulii.org/ug/legislation/consolidated-act/206

Land tenure issues

Four management regimes exist in Uganda:

- **Private property (freehold** and **leasehold** systems). The owner of the property has full rights of accessibility and exclusive use backed by law and is free to transfer the same by sale or inheritance. Properties have titles ownership in the names of the holder.
- **Common property**: The common entails land or water sources for community use. Public areas, rivers, streams and forests that are supposed to be used by everybody as long as they can be clearly identified in the community.
- **State property**; these include some lakes, national parks, wetlands, and forests that are gazetted and with restricted access to the private households. Lack of portrayal of immediate benefits to individual households of state properties has led to encroachment. Wetlands also fall under state ownership stretching 100m from the water-land boundary.
- **Open access** includes lakes and rivers that are free for use by communities without blocking other communities access.

Table 17 Land tenure issues for Ugandan Aquaculture Parks

Issue	Land-Based Aquaculture Parks	Water Based Aquaculture Parks
Land-Tenure	Designated area in Apac is Private Property	Currently lakes are Open-Access
Issues to address	Current owners and those living on the land will have to be compensated and relocated according to law. This is a process that would take at least a couple of years. Given the acreage required (200 ha. In this case, it would be easier/quicker/cheaper to implement if pilots were done on already held government pieces of land, e.g. agricultural schemes.	Security of operators cages and conflicts with other users rights of access. In the event that a limited fishery can be permitted around the cages, this has to be clearly defined (i.e. who, what type of fishery, etc).
Ownership of Aquaculture Park	Land title would need to be secured in the name of the Aquaculture Park (i.e. parks should become designated areas legally to avoid them being used for other purposes or sold off before the specified tenure)	Permits will need to be made and given to cage culture that secure the rights of operators and restrict access for other uses/users to the parks. The parks should be exclusive for fish farming.
Tenure Period	Given the level of investment for establishing the Aquaculture Park, a tenure of 99 years is recommended for the Aquaculture Park investor and a minimum of 10 years for individual holders within the park.	A tenure period of 15 years for the park pending review of the likely impacts on water quality and other environmental changes that have yet to be quantified. After an EIA review, the tenure for additional parks can be reviewed.

Operators	Operators within the park would sub-lease their plots (i.e. units) for a minimum of 10 years. In the event that a park is jointly owned by the operators (e.g. cooperative), then the operators shall have rights of tenure as above in lieu what is additionally stipulated in their charter.	Operators within the park, sub-lease their plots (i.e. units) for a minimum of 10 years. In the event that a park is jointly owned by the operators (e.g. cooperative), then the operators shall have rights of tenure as above in lieu what is additionally stipulated in their charter.
Common Resources	The use and disposal of common resources i.e. water shall be governed by the current laws (i.e. Water Act and NEMA statute) in addition to operating standards agreed by Aquaculture Park management committee.	The overall use of the water resources would be governed by the Water Act and NEMA statute. The Fisheries Act, inclusive of the Aquaculture Rules and Regulations would also apply.

A substantial area of land amounting to around 200 hectares is envisaged for the land-based Aquaculture Park. The area identified in Apac is private property with some communal land that would be deemed common property. The acquisition of the land for the Aquaculture Park would therefore require negotiation with land-owners and village elders. Some compensation is assumed within the capital cost estimate, but not purchase at full market rate. Land tenure issues are therefore likely to lead to delays in implementation with significant additional costs for land-based parks.

The lake-based Aquaculture Park has a comparatively small footprint on land, but lake-side land can come at a premium. The Mwena site has the advantage of it already being acquired for the landing site infrastructure, with additional land available adjacent to the fenced compound. Minimal land aquisition costs are therefore expected for Mwena with no delay to implementation.

14 Conclusions

Technical feasibility
Both land based and lake based Aquaculture Parks are technical feasible in terms of the species and technology for commercial scale fish production. However the concept relies on the improvement of the present production techniques and the use of improved seed and feed.

The land based Aquaculture Park will rely on pumped water from a permanent water body and so will incur higher operating costs than the lake based Aquaculture Park where water flow is passive. There are areas in Lake Victoria that are sufficiently deep for the installation of larger commercial High Volume Low Density cages. However there should be carrying capacity estimations undertaken to ensure the long term sustainability of the proposed level of production in that area.

There are also potential risks from floating aquatic plants and suds.

Economic feasibility
The economic feasibility of the cage based Aquaculture Park at Mwena found the following:

- The model cage Aquaculture Park is estimated to cost 8.2bn USH to build, the existing Mwena site reduces this cost to 5.6bn USH.
- At full capacity the Aquaculture Park, generating revenue from a variety of sources (seed and feed sales, marketing fee and a service charge) is highly profitable at 79%.
- The break-even point for the proposed 3,000t capacity Aqupark is 600t (20% of capacity).
- With production assumptions based on improved culture practice, all scales of farmer are profitable, with those profits increasing with scale: 7% for small scale, 28% for medium and 40% for large.
- With the reduced borrowing for capital investment at Mwena, small scale investors achieve a positive NPV indicating it is worth investing in the park.
- With the combination of comparatively low investment costs and good profits, the results for the medium-scale investor are most positive.
- For the large scale investor with substantial capital costs in shares and cages, the park represents a long term investment.
- Returns on investment (based on 50% of company profits being distributed to shareholders) are achieved after 10 years at Mwena (13 years in the model case).
- A more positive outcome would be achieved with quicker phasing in of production.
- As the viability of the park company is dependent on a certain scale of production, which will mainly be derived from the large scale producer, an alternative approach is for the nucleus estate approach to be adopted where more of the capital costs are held by the public sector in the early stages, but the private sector would still manage production.

The economic feasibility of the pond-based Aquaculture Park at Apac found the following:

- Capital costs of 9.6bn USH are estimated for the pond-based Aquaculture Park
- Investment in the park, even for the smallest viable scale, is unlikely to be open to small-scale farmers (56million assuming 50% of capital costs recovered by farmer investment). Groups of farmers, potentially under a co-operative structure are more likely investors.
- Investment by the large-scale operator is at a lower level than the cage-based model as it represents around 24% of production area compared to 80% for the cages.
- All scales of farm considered are profitable (19%, 31% and 38% for small medium and large scale producers respectively), providing good levels of return after various (service & marketing) charges are paid to the AP company.
- While investment in the AP company should provide returns in the long term, the IRR after 10 years is -6%. It should therefore be considered as providing access to the benefits of operation within the AP, i.e. the ability to establish production at a far lower capital and operating costs than operating alone.

Marketing

- The Aquaculture Park Company will manage the marketing of the product. In this way farmers can benefit from the larger scale of production and marketing expertise of a larger organisation, without feeling they are simply contract growers.
- Quality will be assured on all outputs from the AP through tight control of harvest procedures and post-harvest handling in temperature controlled and hygienic conditions.
- The high production standards proposed for the park presents the opportunity to develop a high quality brand for Aquaculture Park fish
- Initially the AP is expected to supply the buoyant regional markets, selling to existing regional traders that are currently purchasing from multiple producers throughout Uganda.
- Larger sizes suitable for filleting and the growing demand for value-added products, particularly for catfish, indicates that linkage with processors could also be advantageous.
- Growing the Ugandan market for farmed fish should form a part of any market strategy and wider development of the sector using market promotions and awareness-raising to explain the benefits (nutritional and environmental) of AP farmed fish.

Funding options

- Funding options explored include the EU Equity fund, production grant schemes such as Sawlog and commercial loans for small and medium scale to invest in the Aquaculture Park.
- Larger scale investors are identified from within the aquaculture sector in Uganda and overseas (China, Norway, etc.).
- The AP model also provides an opportunity for potential investors from outside aquaculture to diversify into the sector as a high level of technical assistance is proposed along with continued MAAIF support to the venture. Existing large-scale agricultural companies such as Mukwano and Bideco should therefore be approached in addition to aquaculture interests.
- MAAIF should work with Uganda Investment Authority to develop a prospectus for potential investors of all scales. The availability of credit at more preferential rates to current commercial credit should also be explored with funding institutions.

15 Recommendations

Way forward for Aquaculture Park development

It is recommended that the Aquaculture Park concept is developed further as a way to facility a step-change in aquaculture production in Uganda. The concept is particularly appropriate for the following reasons:

Science-based aquaculture practices

There are presently traditional practices in aquaculture, which lack scientific basis. In the Aquaculture Park area, it is recommended that these be avoided. Improved culture technology and methodology should be used from site selection, production, harvesting, monitoring, etc.

In siting, location can be identified by using modelling as a tool. It can identify suitable areas for cages and for ponds. Moreover, guidelines on stocking density, spacing between cages and design and sizes of cages can be prepared using carrying-capacity as a guide. In addition, BMPs and use of effluent water for irrigation can be adapted as part of the operation protocol.

To ensure success of AP, it should be grounded solidly in science with the adoption of well-proven good practice in the planned culture species.

Avoidance of conflict

During the establishment and operation of the Aquaculture Park there can be conflicts for example the displacement of local fishermen or local communities within the area. These conflicts can be avoided by participatory discussions at the planning stage and finding ways for the local communities and local users of the coastline to benefit from Aquaculture Park development.

Socio-economically positive

Aquaculture Parks will directly generate wealth and employment in rural areas (280-400 jobs directly associated with the model cage and pond parks). Operation in APs includes ancillary services that will provide jobs to the local communities, for example, cage makers, net makers, net menders, net cleaners, ice plant workers, harvesters, etc.

Economically profitable

One of the aims of the Aquaculture Parks is the promotion of not only environmental-friendly technology and practices, but economically profitable aquaculture industry as well.

Feed is the major operational cost and the use of poor quality feed and poor feeding practices reduces profitability. One way to counter this is the promotion of good quality feeds and good feeding practice to reduce FCRs. This will minimize food cost and food wastage, thus ecologically- and economically positive.

Creation of cooperative among farmers

To encourage cooperation among farmers, it is recommended that the management committee is made up primarily of farmers wherein there will be a collective decision and action regarding operation of the Aquaculture Park. Buying and selection of feeds is just one of the examples wherein collective action can work. Marketing of the harvest, purchase of materials, monitoring of water quality, etc. can also be pursued successfully if done collectively.

Public-private partnership (PPP)

The Aquaculture Park should be developed through a Public–private partnership as a private business venture which is funded and operated through a partnership of government and one or more private sector companies.

The PPP should involve a contract between a public sector authority and a private company, in which the private company operates the AP project and assumes substantial financial, technical and operational risk in the project. Initially the Government will provide funding but divests its funding to the private sector as the project develops. In this way the project costs and services will eventually be borne exclusively by the users of the service and not by the taxpayer.

Transparency
Transparency in terms of data, accounting system and resolutions are important in keeping the communication open among the farmers and the management. Moreover, it is also a good way of dissemination.

In Philippine Mariculture Parks, monthly monitoring results, harvests and stocking are posted on boards where anyone can see. This practice is a good way of feed-backing the results back to farmers as well as to the management. It also a good tool in "policing" (or monitoring) farmers that are not following the protocol.

Self-replication
It is still a challenge to develop a MP model that can be replicated throughout the whole country. It is because each locality is different, i.e. governance and local. However, it should be a main goal to create a generic model or framework that can be adapted within each locality. One strategy that can be used is the development of pioneer Aquaculture Parks to develop a critical mass that can jump-start the process that others can follow-through.

Self-sufficiency
One indicator of success in AP management and operation is when you can see that it becomes self-sufficient and operated by the private sector. The AP framework should be designed with this in mind. Operational management should include capacity-building and people empowerment from the point of entry up to point of exit, thus, making AP sustainable.

Capacity-building programs such as water quality monitoring, basic accounting, fry and feed quality control, building institutional linkages and community organizing are some example activities that can be incorporated in the AP plan.

Climate-proofed
Some sites selected may be prone to floods or storms. Repair costs and materials contribute to high operational cost and can contribute to losses especially to small-scale farmers.

Recommendations on Aquaculture Park development

It is recommended to:

- Progress the Mwena cage-based Aquaculture Park as it can be quickly implemented at a lower capital cost and higher profitability than for the land-based Aquaculture Park at Apac.
- Include a budget of 5.6 billion USH in the next National budget to establish the lake based cage Aquaculture Park at the Mwena landing site.
- Undertake further study of the pond based Aquaculture Park at Apac particularly for the land tenure issues and pumping head requirement.
- Undertake further analysis of the community scale Aquaculture Park models.

Action plan for implementation

Steps for implementation

The main steps in the planning, implementation, management and review process are outlined below:

Step 1 – Initiation and planning
Step 2 - Site identification and suitability assessment
Step 3 – Background studies and design
Step 4 – Infrastructure development and start-up
Step 5 - Co-management and coordination
Step 6 - Monitoring and control.
Step 7 – Evaluation review and feedback

Timing

The planning and implementation is best done as a participatory process. Therefore, sufficient time will be needed to obtain the political and financial support of policymakers/government and the cooperation and acceptance by stakeholders to ensure the legitimacy of any plan that is developed. Therefore some steps take longer to implement than others.

Step 1. Initiation and planning

The first step in undertaking the comprehensive planning process, should begin with the formation of a task force (and election of a leader) and the development of a draft planning schedule.

It should ensure that it does not cause major conflict with local communities, stakeholders and other users of the coastline.

Key actions

Discussions with local Government and stakeholders on:

- The concept of the Aquaculture Parks, the steps to implement and the benefits for sustainable planning and management
- Project plan and budget for the preparation of the draft management plan
- Assessment of the available resources – institutional capacity
- Initial process planning and stakeholder support
- Formation of a local MP taskforce and elect a team leader,
- Identify Government agencies and representatives
- Clarify transparency issues
- Clarify oversight issues

Main outputs

- Formation of an AP project team and identifying the team leader.
- An action plan that outlines the specific methods and tools to be used during the planning process, that identifies stakeholders, participants, resources, timing, timelines, etc.
- Decision to proceed with the Aquaculture Park or not at this time.

Step 2. Site identification and site suitability assessment

- Data collection
  - Bio-physical data
  - Hydrological data
  - Infrastructure (roads, etc.)
  - Utilities (electricity, telephone coverage, etc.)
  - Sensitive habitats and species, MPAs
  - Hazards
- Undertake a rapid environmental baseline survey
- Identification of Stakeholders
- Identification of risks (floods, storms, suds, algal blooms, etc.)
- Data analysis using GIS against site selection criteria
- Prioritising sites and zones
- Ground truthing the identified zones

Activities

- Commissioning and undertaking the background reports
- Commission baseline study
- Data collection and synthesis
- Literature review and synthesis

Key actions

- Identify and compile any available information on the key target species, culture systems and the ecosystem it operates within including a review of past assessments, studies or management plans.
- Collate relevant local and national policies and identify any possible constraints;
- Summarise the social and economic status and issues of the aquaculture participants, the relevant communities;
- Identify any other key activities, stakeholder groups, government agencies, etc. that need to be included in the planning process (directly or indirectly) to enable its effective and successful implementation.
- Clarify management control for the activities and people to be covered in the plan.

Main outputs

- Collection of environmental and social baseline data and report that clarifies what aquaculture activities are to be managed, the community objectives to be achieved, social values to be observed.

Step 3 – Background studies and design - Environmental baseline study and carrying capacity modelling

Key Actions

- Identify and agree on which aquaculture activities, sectors, communities, target species and culture systems, geographic boundaries of the Mariculture Park
- Identify geographical limits to the zone
- Identify potential species and potential culture systems

- Environmental baseline survey to identify potential environmental issues
- Programmatic EIA for the proposed zone and level of production
- For cage Aquaculture Parks, undertake wave (and possibly water current) modeling to determine level of exposure and recommended mooring design
- Undertake carrying capacity modelling to estimate the maximum sustainable level of production for the zone
- Undertake modelling to find the optimal layout of the park in terms of production.
- Undertake planning of the mooring systems and cost estimate

Step 4 – Implementation - Infrastructure development and start-up
Key actions

- Clarify land title issues and secure land
- Clarify sea use issues and secure licence to operate
- Assign staff to the project to participate in meetings, planning, implementation and monitoring
- upgrade
    - Roads
    - Jetties
    - Shoreline protection
    - Utilities to the shore base
- Identify the potential site and make suitability assessment in consultation with District Officers
- MAAIF act as lead agency in planning, operation, management, monitoring and evaluation of the MP in coordination with District Officers
- Provide initial seed funding for maker buoys, training facilities and techno-demo cages
- Operate techno-demo cages and provide technical assistance to locators and investors
- Supervise and administer the construction and installation activities, procurement of supplies and materials according to plans and specifications
- Facilitate hands-on training and provide technical services to the prospective operators,
- Coordinate with other Government agencies and NGO in the formulation of plans and specifications for the construction and installation of moorings, marker buoys, physical facilities, fish cages and nets
- Endeavour to initiate and encourage local and foreign investment
- Develop or revise Better Management Practice Guidelines and encourage implementation by operators

Step 5 - Co-management and coordination
Key Actions
Form the

- Executive Management Council
- Mariculture Park Management Committee

Encourage Private public partnership

- Feed supplier outlets

Coordinate upstream activities

- Hatchery,
- nursery

Encourage development of support activities

- Cage makers
- Net makers
- Net cleaners
- Ice suppliers

Coordinate downstream activities

- Processing
- marketing

Technical advice and inputs

Coordination of stocking, harvesting and disease monitoring and treatment

Step 6 - Monitoring and control.

MAAIF monitoring and technical coordination

- Provide regular technical monitoring and evaluation of progress and impact
- Undertake regular environmental monitoring

Document the production performance, marketing and any problems and evaluate and report on the AP performance in delivering acceptable community benefits and outcomes.

Regularly report the outcomes to all stakeholders so they are informed of the performance and progress.

Step 7 – Evaluation review and feedback

Evaluation and review of performance is a critical step in the adaptive management planning process. It is essential both to ensure adequate performance is being generated against current objectives but also that the fishery is maintaining relevance with community expectations.

Undertake periodic reviews of the outcomes to determine whether the activities undertaken are generating an acceptable level of performance. Adjust management if necessary

Activities

Review of policy and strategy based on AP implementation feedback

Key Actions

· Regularly review the productivity, livelihood generation and environmental impact
· Where performance is not acceptable, implement corrective actions or examine what-possible alternative management measures may be appropriate.

Recommended further studies

There are a number of additional studies that it is recommended to undertake.

Site suitability study

There needs to be further site suitability studies on the proposed sites (Apac and Mwena) including topography, bathymetry, water quality, soil characteristics, land ownership, etc.

Carrying capacity study

There needs to be carrying capacity estimation undertaken for the identified Aquaculture Park zones using modelling to determine the maximum production the site can sustain.

The carrying capacity aspects should estimate potential sustainable aquaculture production (using the precautionary principle) based on existing production per area on land (Kajansi and Source of the Nile) and existing fish production in cages in the lake (NaFIRRI and Source of the Nile) combined with the potential available areas to estimate potential National sustainable aquaculture production.

National aquaculture scoping and zoning study

In order to determine how the Aquaculture Park concept can be replicated in Uganda, there is a need for a National aquaculture zone identification study using satellite image analysis, GIS and site selection criteria.

This study should identify potential areas and sites for the establishment of aquaculture projects in the immediate coastal hinterland (for land-based fish farming in ponds and tanks) as well as the lake based fish farming in cages.

The site identification aspect for coastal and lake aquaculture mapping should use satellite imagery combined with other available mapped information (such as coastal habitats, and planning zones, as well as coastal features such as water depths and topography) using GIS to determine potential aquaculture production taking into consideration restriction due to potential conflicts.

Long-term technical assistance

There is the need for long-term technical assistance for Aquaculture Park set up and training. A potential donor should be sought to fund this.

Strategic Environmental Assessment of cage culture in Lake Victoria

There should be SEA undertaken for Aquaculture in Lake Victoria with recommendations on the maximum scale of cage farming. The SEA should analyse the policy and legislative framework, describe lake based fish farming systems, including the logistical and environmental suitability requirements; highlight the potential environmental impacts of lake based finfish cage culture and possible mitigation thereof. The study should also focus on the development and application of site selection criteria and use of GIS analysis to identify potential suitable sites for the development of fin fish cage culture.

Review of legislation and regulation frame work with recommendations

The legislative requirements for aquaculture at the institutional, governance and administrative level are substantially different from those for fisheries. Aquaculture is directly affected by land laws, including the use of public domains, such as foreshore, lake, river or wetland areas, water laws, environmental laws, animal health and animal disease laws, fish and game laws, and trade laws, as well as others applying more generally (e.g. public health and sanitary laws, import and export laws, tax laws etc.). This, in turn, raises more complex questions about the jurisdictional roles of institutions and organizations.

In recent years growing attention has been given to the role of law and legal institutions in aquaculture development. Numerous countries have enacted specific rules relating to aquaculture under an aquaculture-specific legislative text. Such laws typically address:

- the overall institutional framework and orientations for policy development
- define the responsibilities and functions of the agency or agencies involved in relation to the development, operation and management of aquaculture
- the framework for aquaculture planning activities
- the framework for aquaculture site allocation processes
- the legal rights flowing from the granting of concessions/leases including private and community rights over ownership and use of land and water resources on which aquaculture is depending
- participation in the decision-making processes
- the delegation of authority for the management of aquaculture developments
- the scope and application of government powers, including authorized government officials, in relation to inspection, monitoring, enforcement, etc.

Particular issues in Uganda, which are central to the determination of an effective framework for aquaculture, concern the need to clarify the long-term allocation and permitting for both coastal land and offshore lake areas. These processes need to be completed before a comprehensive law can be developed.

Annex 1 – Fieldwork Contact List

The following meetings and visits were undertaken.

Date	Name	Designation	Contact
5.11.2012	Dr. Owori-Wadunde	Principal Researcher, Aquaculture Research and Development Center, Kajjansi	Tel: 0772-502966 Email:
	Patrick Seruyange	Operations Officer, Rural Development, EU-Delegation	Tel: 0414-701000 Email: patrick.seruyange@eeas.europa.eu
	Eng. Ronald Kato	MAAIF, Department of Farm Development	Tel: 0772-423820 Email:
	Okaasai S. Opolot	Director Crop Resources	Tel: 0414-531284 Email: maaifcrop@yahoo.com
	Dominic B. Mucunguzi	Senior Engineer-Watershed Management, MAAIF, Department of Farm Development	Tel: 0772-373337 Email: dmucunguzi@yahoo.com
	Mr. Ben Kiddu	Program Coordinator, WAFICOS	Tel: 0774-955878 Email:
	Ms. Lovin Kobusingye	Administrator, WAFICOS Director, KATI Farms Ltd.	Tel: 0772-989157 Email:
	Mr. Ssebinyansi	Executive Member, WAFICOS Proprietor Mpigi Fish Farm Ltd.	Tel: 0772-405460 Email:
6.11.12	Mr. Borel	Greenfields Ltd. and TIFTC . Member of PPP on Aquaculture	Tel: 0752-764764 Email:
	Mr. Godfrey Kubiriza	Makerere University, Department of Zoology	Tel: 0751-902498 Email:
	Dr. Peter Mulamba	Makerere University, Department of Agricultural Engineering	Tel: 0784-598548 Email:
	Mr. Mike Mugabira	Uganda Investment Authority	Tel: Email:
	Dr. Justus Rutaisire	CEO, Aquafarm Consults Ltd. Member of PPP on Aquaculture	Tel: 0772-501227 Email: jruta@aquafarmconsults.com
	Mr. Teddy Kilama	Union Manager, Uganda Fish Farmers Cooperative Union	Tel: 0782-301711 Email: kilamat2007@yahoo.com
	Mr. Tom Musoke	Kabaganda Fish Farm	Tel: 0772-496745 Email:
	Mr. Patrick Okello	Agribusiness Unit Manager, Uganda Cooperative Alliance	Tel: 0775-12697 Email: pokello@uca.co.ug
	Mr. Kaddu Edward Amooti	Head Institutional Development, Uganda Cooperative Alliance	Tel: 0784-545221 Email: ekaddu@uca.co.ug
7.11.2012	Mr. Wadanya	Ag. Commissioner Fisheries, MAAIF	Tel: 0414-320563/0772-482076
	Dr. R. Tumwebaze	Asst. Commissioner Fisheries, Regulation and Control, MAAIF	Tel: 0414-323546/0772-927889 Email: t60rhoda@gmail.com
	Andrew Alio	Principle Fisheries Officer – Aquaculture, MAAIF	Tel: 0414-534504/0772-567189 Email: andrewalio@gmail.com
	Paul Omanyi	Senior Fisheries Officer - Aquacul-	Tel: 0414-534504/0772-630661

		ture	Email: paulomanyi@yahoo.co.uk
	Eng. Richard Chong	Ag. Director/Commissioner Water for Production, Ministry of Water and Environment	Tel: 0414-505942/0772-500697 Email: richard.cong@mwe.go.ug
	Lydia Kaboyo	Database Manager Ministry of Water and Environ-ment	Tel: 0772-647780 Email: lydia.kaboyo@mwe.go.ug
	Eng. John Twinomujuni	Asst. Commissioner for Water for Production, Ministry of Water and Environment.	
8.11.12	LVFO	IFMP Regional End of Project Evaluation Workshop	
	Allen	Production Manager Source of Nile Ltd.	dacyellen@yahoo.com
	Amon	Production Manager – Cages Source of Nile Ltd.	
	Christine	Accounts/Administrator Source of Nile Fish Farm	Email: christine@lakeharvest.com
9.11.12	Dr. Balirwa	Director, NaFiRRI	
	Dr. Mkumbo	Chief Scientist, LVFO	
	Samson Abura	Information and Database Officer, LVFO	Tel: 0434-125000/0776-859297 Email: sbabura@lvfo.org
	Patrick Blow	Director, Source of Nile Ltd.	0782-640072
10.11.12	Team Meeting		
11.11.12	Travel to Lira		
	David Obot	Local person from community, Apac	Tel: 0772-501985
	Port Master	Masindi Port	
12.11.12	Lira District		
	Ariong	District Fisheries Officer	
	Jackson Atwii	Management/Farmer Olweny Fish Farm	
	Joe Akoma	Cage Farmer, Lango District Aged Foundation, c/o Lira District P. O. Box 556, Lira.	
	Adoko Alfred	Cage Farmer, Lango District Aged Foundation, c/o Lira District P. O. Box 556, Lira.	
	Olet Watson	Cage Farmer, Lango District Aged Foundation, c/o Lira District P. O. Box 556, Lira.	
	Okello John	Cage Farmer, Lango District Aged Foundation, c/o Lira District P. O. Box 556, Lira.	

	Betty Kunde	Cage Farmer, Lango District Aged Foundation, c/o Lira District P. O. Box 556, Lira.	
	Peter Adjungo	Production and Marketing Officer, Lira District	
13.11.12	Dr. Owori-Wadunde	Principal Research Officer, ARDC-Kajjansi	Tel: 0772-502966
	Dr. Martin Serwada	Researcher, ARDC-Kajjansi	Tel:
	Mr. Mujib Nkambo	Researcher, ARDC-Kajjansi	Tel:
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	Eng. Wada	Senior Agricultural Engineer (and a Fish Farmer), MAAIF.	Tel: 0772-372797. Email: bnkowadda2000@yahoo.com
	Eng. Turihohabwe	CEO, Tamp Blessed-3MS JV Ltd., Engineering Consultant.	Tel: 0392-948747. Email: alexturiho@yahoo.co.uk
14.11.12	Jean-Loius Veux	EU-Delegation, Equity Fund	
	….	SPGS, Sawlog Production Grant Scheme.	Tel: 0312-265332/3
15.11.12		Eng. Torach, Water for Production, MAAIF.	Tel: 0772-441957. E-mail:torben_61@yahoo.com
		Travel to Kalangala	
16.11.12	Mr. Baguma	DFO Kalangala.	Tel: 0772-565628
	Mbaleba Wycliff	Assistant Fisheries Officer, Kalangala District.	Tel: 0772-641356
	Cancoo Diamond	Fish Inspector, Mweena, Kalangala.	Tel: 0772-641893. Email: cancoodiamond@gmail.com
17.11.12		Return to Kampala.	
	Mr. Borel	Greenfields Ltd. and TIFTC . Member of PPP on Aquaculture	Tel: 0752-764764 Email:
19.11.12	Ms. Jennifer Muwuliza	Commissioner, Aide Liason Department, MFPED	Tel: 0752-692915 Email: jennifer.muwuliza@finance.go.ug
	Collin Makanga	Coordinator NAO Unit, MFPED	Tel: 0772-390860 Email:collin.makanga@finance.go.ug
		CEO, Uganda Fish Processors and Exporters Association.	
22.11.12	Patrick Seruyange	Operations Officer, Rural Development, EU Delegation	Tel: 0414-701012 Email:Patrick.seruyange@eeas.europa.eu

Annex 2 – Schedule of activities

Day	Date	Activity	Location
Sat	10	Inception report writing	Kampala
Sun	11	Site visit 6am leave	Kyoga (3 hours from Kampala)
Mon	12	District Fishery officer, Land commissioner Site visit	Return to Kampala
Tues	13	Head of NaFiRRI station Meet project identification team	Kajansi Kampala
Wed	14	Ministry of Finance meeting UgaChick meeting	Kampala
Thur	15	Site visit District Fishery officer	Buggala island
Fri	16	Site visit return 14.00 ferry	Buggala island
Sat	17	Technical and Economic Analysis	Kampala
Sun	18	**Technical and Economic** Analysis	Kampala
Mon	19	Preparation for stakeholder workshop	Kampala
Tues	20	Stake holder workshop **morning**	Kajansi
Wed	21	Follow up activities following workshop	Kampala
Thur	22	Draft report writing	Kampala
Fri	23	Draft report writing	Kampala
Sat	24	Depart PW 15.00	Entebbe
Sun	25	Depart RC 23.00	Entebbe
	30 Nov	Draft report	
	7 Dec	Draft Report Comments	
	22 Dec	Final Report	

Annex 3 – List of workshop invitees

	Organisation	Name	Contact
1	Project team	Patrick White	
2	Project team	Rod Cappell	
3	Project team	Nelly Isyagi	
4	Project team	Rita Amolo	
5	EU delegation	Patrick Seruyange	EU Delegation, Kampala. Tel:0414701012, Email: Patrick.seruyange@ec.europa.eu
6	MAAIF	The Commissioner for Fisheries Resources	lovewadanya@yahoo.com
7	MAAiF	The Commission of Fisheries, Regulation and Control	T60rhoda@yahoo.com
8	MAAIF	The Commission on Agriculture Planning	maaifcrops@yahoo.com
9	MAAIF	Senior Aquaculture Officer	paulomanyi@yahoo.co.uk
10	MAAIF	Ronald Kato	Tel. 0772 423820
11	MAAIF	Dominic Mucungzi	dmucunguzi@yahoo.com
12	MAAIF	Andrew Alio	andrewalio@gmail.com
13	Kalangala District Authority	District Fishery Officer, Kalangala	
14	Kalangala District Authority	Chief Administrative Officer or Production secretary	
15	Lira District Authority	District Fishery Officer, Lira	
16	Lira District Authority	Chief Administrative Officer or Production secretary	
17	Uganda Investment Authority	Michael Mugabira,	PO Box 7418, Kampala. Tel: 0712534781, Email: mmugabira@ugandainvest.com
18	Greenfields, Uganda Ltd,	Philip Borel de Bitche,	Email: iil@infocom.co.ug Managing Director, PO Box 667 Entebbe, Uganda. Tel: 0752764764,
19	Walimi Fish Farmers Cooperative Society (WAFICOS)	Paul SSebinyansi,	Chairman, Cooperative Society, PO Box 6213 Kampala. Tel: 0312265896, Email: waficos08@yahoo.com
20	farmer	Tom Musoke, Secretary	PO Box 6213 Kampala Tel: 0772496745
21	WAFICOS	Ben Kiddu, programme co-ordinator	PO Box 6213 Kampala
22	Kati Farm Supplies	Kobusingye Lovin	P.O. Box 30026 Kampala latifarms@yahoo.com
23	Aquafarm Consults (farmer)	Dr Justice Rutaisire,	jruta@aquafarmconsults.com
24	National Fisheries Resources Research Institute (NAFiRRI)	Dr John Balirwa, Director	PO Box 343, Jinja. Tel: 0772620505, Email: jbalirwa@yahoo.com
25	NAFiRRI, ARDC	Head of Station	
26	NAFiRRI, ARDC		
27	NAFiRRI	Additional	
28	NAFiRRI	Additional	

29	Ugachick	Aga Sekalala, Managing Director	PO Box 12337, Kampala. Tel: 0772702905, Email: sekala-la@infocom.co.ug
30	Source of Nile	The Manager,	SON Fish Farm, PO Box 322, Jinja. Tel: 0753240989
31	NEMA	The Executive Director	Environmental Monitoring & Compliance, NEMA, PO Box 22255, Kampala. Tel: 256 414 251064/5/6, Mob: 256 772 471139. Email: wayasika@nemaug.org.
32	Uganda Cooperative Alli-ance	Teddy Kilama	
33	Makarere University	Dr. Peter Mulamba	Agricultural Engineering Dept
34	LVFO	The Executive Secretary	Lake Victoria Fisheries Organisation, PO Box 1625, Jinja. Tel: 0772721455, Email: dnyeko@lvfo.org
35	National Agricultural Advi-sory Services (NAADS)	The Executive Directors	
36	Ministry of Finance	PCNAO Unit	Tel. 0772390860
37	Department for Water Resources	Commissioner for Water Resources	
38	National Planning Authori-ty	The Executive Director	

Annex 4 – Stakeholder Workshop Agenda

VENUE: NAFiRRI, Kajansi, UGANDA

DATE: 09.00-13.00 20TH NOVEMBER 2012

Workshop Objectives

The objectives of the stakeholder workshop are:

1. To brief delegates on the key findings and recommendations of the mission;
2. To provide an opportunity for feedback and consensus on the key findings and recommendations and clarification on issues as an input to the mission's draft report; and
3. To provide a forum for the exchange of ideas with regard to the development of Aquaculture Parks in Uganda.

Proposed Agenda

Project title : Feasibility study to design, cost and operationalize model commercial Aquaculture Parks in Uganda

Workshop : Presentation of initial findings and stakeholder feedback

Date: 20 November 2012

Venue: Aquaculture Research & Development Centre, Kajjansi.

Time	Activity	Responsibility
08:30 – 09:00	Registration	
09:00 - 09:15	Welcome, introduction and prayer	MAAIF
09:15 – 09:30	Aquaculture Park concept	Patrick White
09:30 – 09:45	Technical and engineering aspects	Nelly Isyagi and Rita
09:45 – 10:00	Marketing and economic analysis	Rod Cappell
10:00 – 10:20	Tea and Coffee break	
10:20 – 11:20	Open discussions	
11:20 – 12:50	Funding and Implementation Discussion	
12:50 -13:00	Wrap up	

* Please note that the session times will be adhered to as closely as possible but they are indicative and some adjustments may need to be made

ANNEX 5. STAKEHOLDERS WORKSHOP REPORT

Figure 29 Aquaculture Parks Workshop Attendees, NaFIRRI, Kajansi

The main points that were raised and discussed at the workshop included:

- **Governance**. Need for legal framework for aquaculture zoning and cage aquaculture in lakes. Need for conflict resolution procedures.
- **Government support**. Development of nucleus farm and support for out growers
- **Funding for small scale farmers**. Identification of funding source and possibility of a grace period for loan repayment. Initial funding support of small and medium enterprises. Adaptation of the forestry loan model for Aquaculture Parks.
- **Private sector**. Identification of the different types of investor. Criteria for the selection of farmers to participate
- **Marketing**. Possibility of branding of Aquaculture Park products. Potential for distribution to the local market. Potential problems of exporting sex reversed tilapia to the EU. Ware housing products.
- **Sustainability**. Multi use of water, and potential use of green energy
- **Inputs issues**. Seed quality and price. Feed quality and price.
- **Gender issues** especially encouraging women's involvement in the marketing area
- **Socio economic issues** and benefits to local communities. Potential benefits for and competition with outside producers

ANNEX 6. INFORMATION SOURCES

Published information sources included the following:

- Aquaculture Management Consultants Ltd (2010). Sustainable Commercial Aquaculture for Poverty Alleviation (SCAPA) – Fish Market Study Report
- Boyd, C. (2007). Increasing the aquacultural potential of Uganda. C. Boyd, Univ. of Auburn.
- Delgado, C., Wada, N., Rosegrant, M., Meijer, S. and M. Ahmed. 2003. *Fish to 2020: Supply and Demand in Changing Global Markets*. Washington, DC: International Food Policy Research Institute and Penang; WorldFish Center.
- Dhatemwa, C. M. (2009). Regional Fisheries/Farmed Products Market Study. East Africa. Final Report. Uganda Fish Processors Association/Center for the Development of Enterprise. Regional SDI Programme.
- FAO (1985). Code of Conduct for Responsible Fisheries. http://www.fao.org/fishery/ccrf/2/en
- FAO (2005). National Aquaculture Sector Overview. Uganda. Text by Mwanja, W.W. In: FAO Fisheries and Aquaculture Department (Online). Rome, Updated 19 July 2005. http://www.fao.org/fishery/countrysector/naso_uganda
- GoU (2003). The Fish (Aquaculture) Rules, 2003. Statutory Instruments Supplement No. 81. to The Uganda Gazette No. 52 Volume XCVI, 22nd October, 2003
- Isyagi, A.. N. (2007). The Aquaculture Potential of Indigenous Catfish (Clarias gariepinus) in the Lake Victoria Basin, Uganda. Ph.D. Thesis. Stirling University.
- LVFO (2008). The Fisheries Management Plan for Lake Victoria 2009 – 2014. Lake Victoria Fisheries Organisation, Jinja.
- Megapesca (2006). Aquaculture in Uganda: a review of the sub-sector and a strategy for its development. Ministry of Agriculture, Animal Industry and Fisheries. Plan for the Modernisation of Agriculture Secretariat. Supported by the European Union. MegaPesca Lda, Portugal.
- Miller, J.W. & T. Atanda (2011). The rise of peri-urban aquaculture in Nigeria. International Journal of Agricultural Sustainability 9(1) p. 274-281
- Ministry of Agriculture, Animal Industry and Fisheries (2004). The National Fisheries Policy. Department of Fishery Resources. Ministry of Agriculture, Animal Industry and Fisheries, Kampala, Uganda.
- Ministry of Agriculture, Animal Industry and Fisheries, 2004. The National Fisheries Policy. Department of Fishery Resources. Ministry of Agriculture, Animal Industry and Fisheries, Kampala, Uganda
- Ministry of Agriculture, Animal Industry and Fisheries, 2003. The Fish (Aquaculture) Rules, 2003. Statutory Instruments Supplement No. 81. to The Uganda Gazette No. 52 Volume XCVI, 22nd October, 2003.
- Ministry of Water, Lands and Environment, 1998. The Water Resources Regulations, 1998. Statutory Instruments Supplement No. 20 to The Uganda Gazette No. 52 Volume XCI, 21st August, 1998.
- NORAD (2009). Identification of Potential Aquaculture and Fish Processing Investment Projects and Partners in Selected Countries in Africa. Nordenfjeldske Development Services/Econ Poyry. Study commissioned and financed by NORAD (Norwegian Development Assistance Agency.
- Poseidon/Cowi (2011) Study on commercialisation of aquaculture in Uganda
- The Environment Impact Assessment Regulations, 1998. Statutory Instruments Supplement No. 8 to The Uganda Gazette No. 28 Volume XCI, 8th May, 1998.
- The Constitution of Uganda. The Land Act Cap 227 2004. LDC Publishers. Pp4979-5051.

- The Constitution of Uganda. The Water Act Cap 152 2004. LDC Publishers. Pp3567-3634.
- Uganda Investment Authority (2009). Investing in Uganda's Fish and Fish Farming Industry. Fisheries Sector Brief. 2009. Document No. 19.002/Qlt/Fisheries Sector
- USAID FISH Project (2009). Project Report.
- Water (Waste Discharge) Regulations, 1998. Statutory instruments supplement No. 20. Pp447-481.
- Water Resources Regulations, 1998. Statutory instruments supplement No. 20. Pp483-547.
- Water Statute, 1995. Statutory instruments supplement No. 7. Ministry of Lands and Environment, Directorate of Water Development. . UPPC, Entebbe. Pp82.
- Wathum, P. and Rutaisire, J. (2008). Uganda National Aquaculture Development Strategy. Draft Strategy. Funded by the Food and Agriculture Organisation (FAO), Uganda.

ANNEX 7. THE PROJECT TEAM

Patrick White (team leader, Aquaculture Parks specialist). An expert on Aquaculture Parks, fish hatchery and fish/shrimp production, Climate Change impacts on aquaculture and the impact of aquaculture on the environment. He has over 30 years of experience in the aquaculture sector and has worked in Africa, the Mediterranean, the Middle East, and most often in Asia and the Pacific Region (which accounts for around 95% of total global aquaculture production) in Philippines, Vietnam and Indonesia. He will thus be able to bring to this project his own personal experience of aquaculture and Aqua culture Parks and small scale cluster farming in the these countries. His knowledge and expertise covers all major commercial species, including the two main species which will be the focus of this project: tilapia and catfish. He strengths also include the fact that he has worked both as an aquaculture consultant, but also in the commercial fish farming sector. Furthermore, he has led a two-year project for the establishment and sustainable operation of Aquaculture Parks in the Philippines. He has previous experience of working in Uganda, having worked on the EU-funded project 'Aquaculture in Uganda: a review of the subsector and a strategy for its development' in 2006.

Rod Cappell (aquaculture economist, marketing) is a Director of Poseidon with post-graduate degrees in Marine Resource Development and Environmental Economics. He has 17 years of experience in the fisheries and aquaculture sectors for public and private sector clients around the globe. Rod has worked on a range of aquaculture projects from sustainable shrimp production in Bangladesh & Vietnam, to value chain analysis of Atlantic salmon production in Scotland, Chile and Norway. Recent and on-going projects include assessments of mussel culture systems in Europe and South America. This year Rod provided economics expertise to aquaculture development in Saudia Arabia, assessing viability of marine Aquaculture Parks (clusters) and various scales of freshwater recirculation systems. He is also undertaking fisheries valuations of marine protected areas and development zones. He is currently producing the China seafood profile for WWF, which combines the use of trade analysis with management and policy aspects to identify potential leverage points in key supply chains. It uses the MSC and ASC standards as a framework for assessment of key fisheries or cultured production regions. The work also includes a case study on China's engagement with Africa on trade, development and fisheries agreements. Also of relevance is that Rod provided an uncosted and unofficial internal Poseidon peer review of the Study on promoting commercial aquaculture in Uganda (2011), so he is well versed with the sector in Uganda and the background to the proposed project.

Dr. Nelly Isyagi (Ugandan aquaculture expert) is well-known in Uganda as perhaps the leading Ugandan aquaculture consultant. Now based in the UK, she has almost 20 years of expertise of the Uganda fish farming sector. Nelly has experience and training in veterinary medicine and aquaculture as well as in participatory research methodologies like participatory needs assessment and participatory rural appraisal. She has technical competence in the small-scale production systems, fish feed, and fish seed. Key skills include: Designing production, feed and fish systems and appropriate production technology for Ugandan fish farmers; training in aquaculture for farmers, students and professionals; Assessment of environmental issues and developing mitigation measure for production systems in aquaculture; Setting up demonstration farms, identifying, testing and adopting appropriate technologies; Aquaculture enterprise development both at farm and sectoral development levels; Fish health management - diagnostics and clinical services. Also of note is that she worked on the 2011 study on promoting commercial aquaculture in Uganda, which employed a value-chain approach.

ANNEX 8 Terms of Reference

a) Describe the APs concept and its key elements in terms of design, operations and funding.

b) Prepare an adaptation plan of the APs concept to fresh water farming of tilapia and catfish in Uganda.

c) Carry out an assessment on the feasibility of operating an AP at each of the chosen sites. If feasible carry out a detailed feasibility study to develop and operate the agreed sites using the AP concept for a defined production level of fish.

d) Prepare a preliminary design at each of the chosen and agreed site defining the key elements, infrastructure including a sketch drawing and cost elements. During the study, adequate suitability for expansion should be a key criterion in addition to the biological, hydrological, infrastructure in place, services availability, market access and other key criteria that would affect the ultimate commercial performance of the site. Particular attention should be given to synergies and compatibility for utilizing waste water for irrigation purposes specific to river fed, pond based system.

e) The study is to include an examination of funding options based on a Public Private Partnership (PPP) model, that would attract investments in aquaculture, such as equity financing (large investors) and/or grant scheme (Aquaculture Production Grant Scheme) funding i.e., similar to Sawlog Production Grant Scheme in Forestry Sector (targeting small and medium enterprises).

f) Indication of how financing options can be repaid using projected returns and optimal scales of production.
g) The feasibility should be based on a market driven approach and will include evaluating the domestic and regional markets segments for catfish and tilapia.
h) Include advice on key mitigating strategies in the event of climate change and epidemic control.
i) Close attention should be made to the availability of quality feed and appropriate seed to ensure optimum production from the systems.

j) Each site selected for the detailed study, should be assessed in terms of regulatory requirements concerning environment, legal status of land and water to provide an understanding for such requirements for the development of APs.

Annex 9 Economic Analysis tables

Mwena site balance sheets

all costs in USH

Model 1- Mwena small scale (25 small cages with Tilapia) borrowing 20 million to invest at 22% interest

	0	1	2	3	4	5	6	7	8	9
Capital investment	**-11,100,000**						**-900,000**			
Farm capacity		50%	100%	100%	100%	100%	100%	100%		
Revenue	0	89,852,450	193,800,000	193,800,000	193,800,000	193,800,000	193,800,000	193,800,000	193,800,000	193,800,000
Operating costs	0	-86,945,450	-179,704,900	-179,704,900	-179,704,900	-179,704,900	-179,704,900	-179,704,900	-179,704,900	-179,704,900
operating profit	0	2907000	14095100	14095100	14095100	14095100	14095100	14095100	14095100	14095100
interest on loan repayments		-4,400,000	-4,400,000	-4,400,000	-4,400,000	-4,400,000				
net profit	-11,100,000	-1,493,000	9,695,100	9,695,100	9,695,100	9,695,100	13,195,100	14,095,100	14,095,100	14,095,100
profit per month		-124,417	807,925	807,925	807,925	807,925	1,099,592	1,174,592	1,174,592	1,174,592
cumulative cash flow	-11,100,000	-12,593,000	-2,897,900	6,797,200	16,492,300	26,187,400	39,382,500	53,477,600	67,572,700	81,667,800
NPV	-11,152,697									
IRR	**42%**	**after 5 years**								
IRR	**54%**	**after 10 years**								

Model 2 - Mwena medium scale (50 cages)

	0	1	2	3	4	5	6	7	8	9
Capital investment	**-47,600,000**						**-3,400,000**			
Farm capacity		50%	100%	100%	100%	100%	100%	100%		
Revenue	**0**	**304,542,857**	**609,085,714**	**609,085,714**	**609,085,714**	**609,085,714**	**609,085,714**	**609,085,714**	**609,085,714**	**609,085,714**
Operating costs	**0**	**-218,250,914**	**-436,501,829**	**-436,501,829**	**-436,501,829**	**-436,501,829**	**-436,501,829**	**-436,501,829**	**-436,501,829**	**-436,501,829**
operating profit	**0**	**86291942.86**	**172583885.7**	**172583885.7**	**172583885.7**	**172583885.7**	**172583885.7**	**172583885.7**	**172583885.7**	**172583885.7**
interest on loan repayments (50 million)		-11,000,000	-11,000,000	-11,000,000	-11,000,000	-11,000,000				
net profit	**-47,600,000**	**75,291,943**	**161,583,886**	**161,583,886**	**161,583,886**	**161,583,886**	**169,183,886**	**172,583,886**	**172,583,886**	**172,583,886**
profit per month		**6,274,329**	**13,465,324**	**13,465,324**	**13,465,324**	**13,465,324**	**14,098,657**	**14,381,990**	**14,381,990**	**14,381,990**

cumulative cash flow	**75,291,943**	**236,875,829**	**398,459,714**	**560,043,600**	**721,627,486**	**890,811,371**	**1,063,395,257**	**1,235,979,143**	**1,408,563,029**	**1,581,146,914**
NPV	**-40,772,516**									
IRR	**215%**	**after 5 years**								
IRR	**216%**	**after 10 years**								

Model 3 - Mwena Large scale farmer (72 x 12m diameter cages)										
	0	1	2	3	4	5	6	7	8	9
Farm capacity		20%	40%	60%	80%	100%	100%	100%	100%	100%
AP investment	**-3,235,758,829**									
Capital investment	**-3,235,758,829**	**-900,000,000**	**-900,000,000**	**-900,000,000**	**-900,000,000**	**-900,000,000**	**-808,939,707**		**-**	**-**
Revenue	**0**	**2,321,691,429**	**4,643,382,857**	**6,965,074,286**	**9,286,765,714**	**11,608,457,143**	**11,608,457,143**	**11,608,457,143**	**11,608,457,143**	**11,608,457,143**
Operating costs	**0**	**-1,393,009,554**	**-2,786,019,109**	**-2,786,019,109**	**-2,786,019,109**	**-2,786,019,109**	**-2,786,019,109**	**-2,786,019,109**	**-2,786,019,109**	**-2,786,019,109**
operating profit	0	928,681,874	1,857,363,749	4,179,055,177	6,500,746,606	8,822,438,034	8,822,438,034	8,822,438,034	8,822,438,034	8,822,438,034
net profit	-3,235,758,829	28,681,874	957,363,749	3,279,055,177	5,600,746,606	7,922,438,034	8,013,498,327	8,822,438,034	8,822,438,034	8,822,438,034
cumulative cash flow	-3,235,758,829	-3,207,076,955	-2,249,713,206	1,029,341,971	6,630,088,577	14,552,526,611	22,566,024,938	31,388,462,972	40,210,901,007	49,033,339,041
NPV	-3,226,175,894									
IRR	54%	after 5 years								
IRR	68%	after 10 years								

Model 4 - Mwena Aquaculture Park										
	1	1	2	3	4	5	6	7	8	9
Park Capacity	0%	20%	40%	60%	80%	100%	100%	100%	100%	100%
Capital investment	**-4,540,767,347**	**-900,000,000**	**-900,000,000**	**-900,000,000**	**-900,000,000**	**-900,000,000**				
Revenue	**-**	**591,441,394**	**1,182,882,789**	**1,774,324,183**	**2,365,765,577**	**2,957,206,971**	**2,957,206,971**	**2,957,206,971**	**2,957,206,971**	**2,957,206,971**
Operating costs	**-**	**-128,663,800**	**-257,327,600**	**-385,991,400**	**-514,655,200**	**-643,319,000**	**-643,319,000**	**-643,319,000**	**-643,319,000**	**-643,319,000**
operating profit	-	462,777,594	925,555,189	1,388,332,783	1,851,110,377	2,313,887,971	2,313,887,971	2,313,887,971	2,313,887,971	2,313,887,971
net profit	-4,540,767,347	-437,222,406	25,555,189	488,332,783	951,110,377	1,413,887,971	2,313,887,971	2,313,887,971	2,313,887,971	2,313,887,971
returns to investors			50%	50%	50%	50%	50%	50%	50%	50%
			12,777,594	244,166,391	475,555,189	706,943,986	1,156,943,986	1,156,943,986	1,156,943,986	1,156,943,986
cumulative cash flow	-4,540,767,347	-4,977,989,753	-4,952,434,564	-4,464,101,781	-3,512,991,404	-2,099,103,433	214,784,539	1,371,728,524	2,528,672,510	3,685,616,496

NPV	**831,464,227**									
IRR	**-29%**	after 5 years								
IRR	**15%**	after 10 years								
			3	4	5	6	7	8	9	10
5,000,000	0.09%	small scale investor	$12,038	$230,033	$448,028	$666,024	$1,089,976	$1,089,976	$1,089,976	$1,089,976
cumulative return			$12,038	$242,071	$690,099	$1,356,123	$2,446,099	$3,536,075	$4,626,051	$5,716,026
34,000,000	0.60%	medium in-	$77,043	$1,472,212	$2,867,381	$4,262,550	$6,975,846	$6,975,846	$6,975,846	$6,975,846

		vestor								
cumulative return			$77,043	$1,549,255	$4,416,637	$8,679,187	$15,655,033	$22,630,878	$29,606,724	$36,582,569
2,300,000,000	40.88%	large scale investor	$5,223,521	$99,815,986	$194,408,452	$289,000,918	$472,962,329	$472,962,329	$472,962,329	$472,962,329
cumulative return			$5,223,521	$105,039,507	$299,447,959	$588,448,877	$1,061,411,206	$1,534,373,535	$2,007,335,863	**$2,480,298,192**

Apac site balance sheets

all costs in USH

Model 1- small scale 8 small ponds with Tilapia (borrowing 56 million to invest at 22% interest)

	0	1	2	3	4	5	6	7	8	9
AP investment	**-56,209,914**						**900,000**			
Farm capacity		50%	100%	100%	100%	100%	100%	100%		
Revenue	**0**	100,320,000	200,640,000	200,640,000	200,640,000	200,640,000	200,640,000	200,640,000	200,640,000	200,640,000
Operating costs	**0**	-80,870,082	-161,740,164	-161,740,164	-161,740,164	-161,740,164	-161,740,164	-161,740,164	-161,740,164	-161,740,164
operating profit	-56,209,914	19,449,918	38,899,836	38,899,836	38,899,836	38,899,836	39,799,836	38,899,836	38,899,836	38,899,836
interest on loan repayments	0	-12,320,000	-12,320,000	-12,320,000	-12,320,000	-12,320,000				
net profit	-56,209,914	7,129,918	26,579,836	26,579,836	26,579,836	26,579,836	39,799,836	38,899,836	38,899,836	38,899,836
profit per month		594,160	2,214,986	2,214,986	2,214,986	2,214,986	3,316,653	3,241,653	3,241,653	3,241,653
cumulative cash flow	-56,209,914	-49,079,996	-22,500,160	4,079,676	30,659,512	57,239,348	97,039,184	135,939,020	174,838,856	213,738,692
NPV	**-55,491,073**									
IRR	**25%**		**after 5 years**							
IRR	**39%**		**after 10 years**							

Model 2 - medium scale (6 large ponds)

	0	1	2	3	4	5	6	7	8	9
Capital investment	**-134,903,794**						**3,400,000**			
Farm capacity		50%	100%	100%	100%	100%	100%	100%		
Revenue	**0**	**256,526,600**	**513,053,200**	**513,053,200**	**513,053,200**	**513,053,200**	**513,053,200**	**513,053,200**	**513,053,200**	**513,053,200**
Operating costs	**0**	**-177,323,872**	**-354,647,745**	**-354,647,745**	**-354,647,745**	**-354,647,745**	**-354,647,745**	**-354,647,745**	**-354,647,745**	**-354,647,745**
operating profit	**-134,903,794**	**79,202,728**	**158,405,455**	**158,405,455**	**158,405,455**	**158,405,455**	**161,805,455**	**158,405,455**	**158,405,455**	**158,405,455**
interest on loan		-29,700,000	-29,700,000	-29,700,000	-29,700,000	-29,700,000	-29,700,000			
net profit	-134,903,794	49,502,728	128,705,455	128,705,455	128,705,455	128,705,455	132,105,455	158,405,455	158,405,455	158,405,455
balance	**-134,903,794**	**306,029,328**	**641,758,655**	**641,758,655**	**641,758,655**	**641,758,655**	**645,158,655**	**671,458,655**	**671,458,655**	**671,458,655**
profit per month		**25,502,444**	**53,479,888**	**53,479,888**	**53,479,888**	**53,479,888**	**53,763,221**	**55,954,888**	**55,954,888**	**55,954,888**
cumulative cash flow	-134,903,794	**171,125,533**	**812,884,189**	**1,454,642,844**	**2,096,401,500**	**2,738,160,155**	**3,383,318,811**	**4,054,777,466**	**4,726,236,122**	**5,397,694,777**

NPV	**53,479,904**	
IRR	**290%**	**after 5 years**
IRR	**291%**	**after 10 years**

Model 3 - Large scale farmer (50 large ponds)										
	0	1	2	3	4	5	6	7	8	9

Farm capacity	0	20%	40%	40%	80%	100%	100%	100%	100%	100%
Capital investment	**-1,124,198,287**		**-**	**-**	**-**	**-**	**-281,049,572**		**-**	**-**
Revenue	**0**	**905,388,000**	**1,810,776,000**	**1,810,776,000**	**3,621,552,000**	**4,526,940,000**	**4,526,940,000**	**4,526,940,000**	**4,526,940,000**	**4,526,940,000**
Operating costs	**0**	**-559,708,554**	**-1,119,417,108**	**-1,119,417,108**	**-2,238,834,217**	**-2,798,542,771**	**-2,798,542,771**	**-2,798,542,771**	**-2,798,542,771**	**-2,798,542,771**
operational profit	-1,124,198,287	345,679,446	691,358,892	691,358,892	1,382,717,783	1,728,397,229	1,447,347,657	1,728,397,229	1,728,397,229	1,728,397,229
interest on loan		**-220,000,000**	**-220,000,000**	**-220,000,000**	**-220,000,000**	**-220,000,000**				
net profit	-1,124,198,287	125,679,446	471,358,892	471,358,892	1,162,717,783	1,508,397,229	1,447,347,657	1,728,397,229	1,728,397,229	1,728,397,229
cumulative cash flow	-1,124,198,287	-998,518,842	-527,159,950	-55,801,058	1,106,916,725	2,615,313,954	4,062,661,611	5,791,058,840	7,519,456,069	9,247,853,299
NPV	-1,093,148,599									
IRR	39%	after 5 years								
IRR	53%	after 10 years								

Model 4 - Aquaculture Park

	0	1	2	3	4	5	6	7	8	9
Park Capacity	0%	40%	40%	80%	80%	100%	100%	100%	100%	100%
Capital investment	**-9,555,685,443**	**-**	**-**	**-**	**-**	**-1,084,791,666.67**	**-**	**-**	**-**	**-**
Revenue	**-**	**922,842,649**	**922,842,649**	**1,845,685,299**	**1,845,685,299**	**2,307,106,623**	**2,307,106,623**	**2,307,106,623**	**2,307,106,623**	**2,307,106,623**

Operating costs	**-**	**-453,838,223**	**-453,838,223**	**-907,676,445**	**-907,676,445**	**-2,219,387,224**	**-1,134,595,557**	**-1,134,595,557**	**-1,134,595,557**	**-1,134,595,557**
total costs	-	-453,838,223	-453,838,223	-907,676,445	-907,676,445	-3,304,178,890	-1,134,595,557	-1,134,595,557	-1,134,595,557	-1,134,595,557
operational profit	-9,555,685,443	469,004,427	469,004,427	938,008,853	938,008,853	-997,072,267	1,172,511,066	1,172,511,066	1,172,511,066	1,172,511,066
		51%	51%	51%	51%	-43%	51%	51%	51%	51%
		39,083,702.22	39,083,702.22							
returns to investors			50%	50%	50%	50%	50%	50%	50%	50%
			234,502,213	469,004,427	469,004,427		586,255,533	586,255,533	586,255,533	586,255,533
cumulative cash flow	-9,555,685,443	-9,086,681,017	-8,852,178,804	-8,383,174,377	-7,914,169,950	-7,914,169,950	-7,327,914,417	-6,741,658,884	-6,155,403,351	-5,569,147,818

NPV	**-6,044,240,001**	
IRR	**-33%**	after 5 years
IRR	**-6%**	after 10 years

Annex 10. Drawings

Masindi/Apac

D1. base plan including river bathymetry (just the depths that we took), topography, existing road and electricity supply
D2. Base plan (as D1 above) plus ponds, canals, buildings pump house with highlighted inlet and outlet canals
D3. Plan D2 above plus project roads and electricity supply high lighted
D4. Schematic cross section of ponds illustrating pumping head, drainage and optimal land height above river level

Mwena/Bugala Island

D5. Base plan comprising coastline bathymetry and topography with location of landing site
D6. Plan D5 plus proposed cages
D7. Base plan of landing site
D8. Plan D7 with proposed new infrastructure