WRCF

WESTERN REGION COASTAL FOUNDATION

AQUACULTURE DEVELOPMENT INTERVENTION SCALE-UP STRATEGY

Contents

Executive Summary

WRCF seeks to scale up the pilot intervention in aquaculture initially implemented in the Jomoro, Ellembelle and Nzema East Districts with about 120 farmers belonging to 4 different fish farmer associations. The pilot intervention was designed to address the main strategic constraints in aquaculture, which are:

1. Poor production knowledge by farmers leading to large wastage of feed and poor water quality management —resulting in high production cost of catfish farming.
2. Lack of business management knowledge to support resulting in non-profitable operations,
3. Limited access to good quality fingerlings and feed as a result of low market penetration, by hatcheries and feed companies, and
4. Weak relationships between the value chain actors at different functional levels and with end markets, and supporting aqua culture extension and research services.

To tackle these constraints effectively and unlock the economic potential aquaculture has on employment and income levels in the six coastal districts, the team considered three intervention approaches:

Option 1: Support aquaculture extension through a region wide Training of Trainers approach;
Option 2: Support the establishment of local micro fish feed production units to improve feed access;
Option 3: Coordinate the establishment of demonstration ponds on existing sites farmers demonstrating a potential to invest time and resources to learn and adopt improved technical and market oriented management systems.

After rigorous analyses of the above options, WRCF implemented the demonstration pond option as the most appropriate approach to the current stage of aquaculture development in the six coastal districts. Option 3 brought together fish feed companies, hatcheries, consultants and other project partners to improve fish farmers' technical and business management knowledge to enhance their commercial activities. Additionally, option 3 is market-driven as it brings private sector actors into a focused area that improves their interaction. It is also cost-effective because some private sector actors have the incentive to contribute resources as a form of advertisement of their products and services.

Intervention Budget

ITEM	COST (GHC)	COST (GBP)
Capacity building (all farmers)	43,170	7,849
Pond maintenance & equip.	19,000	3,454
Fish feed procurement	66,027	12,005
Consultant fees	68,000	12,363
BUDGET TOTAL	**196,197**	**32,699.5**

Expected Results; As fish farmers applied the technical knowledge and business management principles from the demonstration, adaptation of the improved technology and management practises would lead to improved productivity and increased linkages with the input and end

markets leading to increased profitability. This would in turn enhance their credit profile and position them to be able to more easily access credit facilities from financial institutions.

Results

Establishment of Aquaculture demonstration ponds (Completed May 2016)

In partnership with the Fisheries Commission and the Water Research Institute (WRI), eight (8) sites made available by members of the four associations were designated as demonstration sites. Association members contributed to the project by providing labour services for the reconstruction and renovation of these ponds. The beneficiary farmer who had donated his/her pond for the demonstration was to be given 40% of the total sale of fish from the association. The ponds are located in the following towns:

- Awiebo – Osagyefo Fish Farmers Association
- Kangbuli – Alhamdallah Fish farmers Association
- New Ankasa – Ankasa Conservation Fish Farmers Association
- Takinta – Half Assini/New Kabenlasuazo Fish Farmers Association

Improvement in the Pond and water, *results* in reduced mortality

Farmers gained an increase in profits because of cost savings they achieved through efficiency gains in feed conversion and reduced mortality through good water management. Results from the pilot ponds recorded a positive income over costs by all the four Associations demonstration ponds.

PRODUCTION RESULTS FOR ONE CYCLE (CATFISH PILOT INITIATIVE)				
	ANCOFFA	**KAHA**	**Alhamdallah**	**Osagyefo**
Number of fish stocked	1,235	1,880	2110	1,333
Mortality rate%	5%	10%	5%	5%
Total weight (kg)	1,173.2	1,692	2,004.5	1,266.3
Average weight per fish	1.04	0.97	0.89	1.07
PROJECT COSTS AND REVENUE GENERATED				
WRCF Costs (GHC)	9,953	8,403	10,623	9,457
Partners Contributions (GHC)	5,085	5,221	4,569	3,919
Total Costs	**15,038**	**13,624**	**15,192**	**13,376**
Average price per kilo (GHC)	13	10	10	11
Value of fish consumed and donated for market linkages promotions(GHC)	3,745.34	3,303.4	5,163	1,482.9
Actual cash sales	12,117	13,109	12,677	13,422
Value of fish produced	**15,862.34**	**16.412.4**	**17,840.05**	**14,904**
Net benefits to pond	**824.34**	**1,037**	**2,648**	**1,528**

Given the demonstrated success of the pilot intervention, WRCF believes that there future of aquaculture in the Western Region is bright if support is given to interested community members. WRCF proposes that Oil, Gas and Power companies, mining companies, private sector players, and donors provide support to these interested residents, particularly those from communities affected one way or the other by oil and gas operations. Residents from these communities will be required to have access to land and water. This will enable them construct and operate a model size pond of 100M² with an average depth of 1 M², stocked with 530 fingerlings of 20 gram weight as a standard.

Projections from these pilot results provide a basis for developing a model enterprise budget below. The calculated Internal Rate of Return(IRR)[1] is 16% and operating two cycles per annum at a gross profit per cycle is GHc864 plus a wage income of GHc 950. This is equivalent to an **annual increase in income** of GHC **1,814** per pond constructed, and operated in the community. The required investment outlay is estimated at GHc6, 000, of which capital cost related to land acquisition and the pond construction is 50% with working capital requirements being covered by the other 50%.

Strategic Options for Scaling up

Figure 1 Urban fish farming using a fish tank

The results of the survey suggest that the primary or **current occupation** of all the 70 respondents, is tied to the fisheries industry. Fishing, in coastal communities has a cultural and hereditory/personal connotation attached to the livelihood for those engaged in it. Owing to this strong bond that fishers have towards their livelihood, introduction of alternative livelihoods has been met with strong resistance in the past in many communities.

However, 69 responses were given to the question, "**Have you heard about fish farming?**". Of the number, 64 answered "Yes" and the remaining 5 answered "No". This reflects that many fishers have received some bit of information about aquaculture.

The follow-up question, "**Are you interested in fish farming?**", received a total of sixty-seven (67) responses. Forty-three (43) answered "Yes" and the remaining 24 answered "No", showing a fair level of interest in aquaculture among members of coastal communities.

Conclusions

There is opportunity for introducing aquaculture as an additional income stream to a limited number of persons living in some of these fishing communities given their expressed interest. Support for these persons to successfully start and run a fish farm business either using earthen ponds or the fish tank methods close to their homes could serve as the demonstration point to encourage some other members of the communities to follow suite. The youth and females in the communities could be targeted for support provided they demonstrate some commitment to invest time and some resource to this experiment.

WRCF is looking for partners in the Oil and Gas Industry to pilot this initiative

[1] **Internal Rate of Return:** The IRR of an investment is the discount rate at which the Net Present value of costs of the investment equals the net present value of the benefits of the investment. The IRR rule states that if the internal rate of return (IRR) on a project or investment is greater than the– the cost of capital – then the decision would generally be to go ahead with it.

Background

Ghana's fisheries contribute seven (7) percent to annual GDP and indirectly supports the livelihoods of 2.2 million people or ten (10) percent of all people in Ghana. The fisheries sector, which comprises of both cultured and wild capture fish, generate about US$ 1 billion in revenue each year[2]. Ghanaians consume on average 25 kg of fish per person, per year, which is well above the global average of 13 kg per person, per year. In terms of nutritional dependency on fish, Ghana ranks sixth worldwide and ranks number one in Africa. In recent years, the country has been experiencing significant reduction in its harvest of marine fisheries leading it to rely heavily on imports. Official national statistics indicate a 30 percent decline in wild-capture fisheries in 2011. In 2012, the overall annual fish requirement was estimated at 968,000 MT;[3] however, only about 455,700 MT from the marine and inland fisheries was produced. To make up for the shortfall, 175,341 MT of fish was imported, which still left a large deficit in supply. According to the Ghana Fisheries Commission, there is a current shortfall in the domestic production needed to meet food security requirements.

The introduction of aquaculture in the late 1950s has had a steady growth throughout the years with a total production of 10,000 MT in 2008, to 26,000 MT in 2012. The success of this sector has garnered great interest from donor and international agencies (FAO, NORAD, DANIDA and GTZ) to support aquaculture development. Currently, there is an increased interest in expanding the value chain as more actors, both international and local, begin to stream in since the sector's growth potential is driven off the back of strong market demand. The domestic demand for higher-value products such as vegetables and for some animal products such as chicken and fish has seen an increase due to rapidly growing urban markets in Ghana[4]. At the same time, as fish demand is increasing, marine and inland fisheries catch are on the decline.

Overview of Aquaculture Development in the Western Region

In Western Region, there is strong interest in aquaculture development, based on robust and growing domestic markets, and an increasing gap between fish supply and demand, resulting in high real prices. In 2007, the Western Region accounted for the highest number of earthen ponds per region[5]. This was mainly because the area had large tracts of marginal lands that had the potential of supporting aquaculture production.

Rural farmers in the Western Region have gone into aquaculture as a means to diversify their sources of income away from the core farm production systems of cultivating cash crops such as cocoa, oil palm, coconut and others. Diversifying an existing farm enterprise to incorporate an alternative enterprise is, however, not a risk- free venture. It often requires a demonstrated farmer interest, development of new skills and access to resources such as finance and market opportunities.

[2] Ghana Fisheries and Aquaculture Sector Development Plan (2011-2016)

[3] Source: http://mofa.gov.gh/site/?page_id=2862.

[4] World Bank. (2013a). World development indicators: Ghana. Retrieved from http://data.worldbank.org/country/ghana

[5] Review of National Policies and Programmes on Aquaculture in Ghana 2009

The potential for aquaculture in the coastal zone, has created an important source of livelihood for local communities faced with declining revenues from over-exploited fisheries. The main type of fish cultured within the region is the *clarias* species (catfish).

According to the Regional Fisheries Commission, there are more than 400 fish farming operations in the Western Region, with about 180 in the coastal districts. Most ponds are small, 150-400 m^2, and most operators have about 2-6 ponds. Total operational pond surface area is less than 3 ha per farmer and total output is less than 3 tons per annum per farmer. The food conversion ratio (FCR), a key indicator of system efficiency, should be below 2.0 for pond aquaculture, but the reported value from farmers is 5.0. As a result, the non-application of feeding measuring procedures leads to overfeeding their stock. They are confronted with a catch 22 situation; given the carnivorous nature of the catfish, underfeeding will lead to them devouring each other while over feeding will affect the water quality and reduce oxygen levels because of decomposed leftover feed. From observation of the ponds, the current practises has resulted in highly over-fertile pond waters, which may be reducing growth rates (due to low dissolved oxygen).

In 2013, the Regional Fisheries Commission recorded a 40% decrease in the total number of fish farmers along the coastal districts. The perceived high production costs associated with inefficient use of inputs and low productivity, subsequently resulting in very low returns on investments, has consequently waned farmers' interest in the enterprise.

Strategic Constraints

Constraining small-scale producers from making significant profits are: persistent and pervasive shortages and high prices of feed, seed, and technical assistance. Government extension officers often lack sufficient resources and training, and with no significant sources of alternative technological support, farmers are unable to overcome shortages of fingerlings and other inputs.

To realise the opportunities presented by the sector for poor fish farmers in the six coastal districts, the WRCF intervention was designed to address the following underlying strategic constraints:

1. Poor production knowledge by farmers leading to large wastage of feed and poor water quality management —resulting in high production cost of catfish farming.
2. Lack of business management knowledge to support resulting in non-profitable operations,
3. Limited access to good quality fingerlings and feed as a result of low market penetration, by hatcheries and feed companies, and
4. Weak relationships between the value chain actors at different functional levels and with end markets, and supporting aqua culture extension and research services.

A World Fish Centre study to provisionally identify livelihood diversification opportunities in coastal communities in Ghana's Western Region, suggests that the best options for livelihood diversification generally relate to further development of existing activities. Occasionally, there

may be opportunities to significantly ramp up an existing, but hitherto small activity, in response to a sudden change in circumstances.

Developing more generic livelihood skills (such as improved education, business development skills) coupled with the provision of generic business services (e.g., information centres, micro-finance) will improve individual abilities to identify and seize new livelihood opportunities in a range of sectors.

With little or no record keeping to analyse profitability of the business, and evidence to support credit applications, fish farmers find it difficult to access credit from financial institutions. Additionally, limited technical knowledge and lack of technical assistance limits farmers' operational productivity.

The above constraints manifest within the system as the high cost of growing out fish. Addressing this constraint is particularly important given that fish production, processing, marketing and associated services constitute a significant source of livelihood in the six coastal districts. Despite these benefits, and diminishing marine fish catch, few are involved in the fish farming enterprise, perhaps due to the perception of high upfront capital costs, limited technical knowledge, and absence of the requisite business development skills to manage profitably these enterprises.

The WRCF selected the aquaculture sector for intervention because it fulfilled our key selection criteria—growth potential, impact on the poor and women, and feasibility. The sector's growth potential is driven off the back of strong market demand. The sector's poverty reduction potential is rooted in the sector's strong multiplier effect with additional labour and economic activity revolving around each pond (e.g. feed, fingerlings, services). Finally, the sector's feasibility stems from technological advances, which have increased the efficiency and profitability of actors in the sector and the supporting enabling environment at the national level.

Producer Structure Options

There are currently six aquaculture producer associations in the Region, two in the Jomoro District (60 members), two in the Ellembelle District (30 members) and two in the Nzema- East District (20 members). While the majority own active ponds, a lower percentage have either abandoned their ponds or have intentions to dig a pond or build concrete tanks at some point when the technology is proven. The leadership within these associations seems to include responsible individuals, often community leaders, who might be able to help organize collective action on the part of the group that would enable cheaper purchase and storage of inputs and the negotiation of better market prices for outputs.

Important stakeholders in the value chain within the Region, such as the Abuesi Fish Farmers Association, managers of a fish smoking facility and exporters of smoked fish, have expressed willingness to engage in marketing arrangements with serious farmers who can meet production targets and deadlines.

Analysis of Options

After a preliminary analysis of the fish value chain, which involved engaging stakeholders and investigating current trends in aquaculture development within and outside the Region, WRCF considered the following pilot intervention options to address the constraint discussed above:

Option 1: Support aquaculture extension through a region wide Training of Trainers approach
Option 2: Support the establishment of local micro fish feed production units to improve feed access

Option 3: Coordinate the establishment of demonstration ponds on existing sites farmers demonstrating a potential to invest time and resources to learn and adopt improved technical and market oriented management systems

Option 1: Supporting aquaculture Extension systems through a Training of Trainers approach - This intervention seeks to bridge the poor extension system gap currently provided by the Fisheries Commission. This could be done through building the knowledge of selected lead fish farmers who will in turn provide aquaculture extension support and services for their cluster groups and associations. This includes selection of beneficiaries and collaborating with research and government institutions to provide in-depth aquaculture expertise training.

Benefits: This option will close the technical and business knowledge gap through improved in-depth training. It is a market oriented option since these trained beneficiaries will have the ability to supply their services to other farmers at reduced cost which will be a source of livelihood.

Limitations: While this seems to be a viable option, there is a risk pertaining to its sustainability. It is uncertain that trained farmers will be willing to train other farmers as planned by the intervention. This will have a high impact on the success of this intervention.

Option 2: Support Establishment of Local Micro Fish feed Production Units - Feed represents up to 60% of the cost of growing out fish. One major reason for the reduction of aquaculture production in the region is the high cost of feed. This option seeks to build and/or strengthen enterprise development capacities and help would-be entrepreneurs seize and develop the opportunities they perceive.

This constraint is addressed through support for entrepreneurs to establish micro feed processing units, to enable farmers to substitute high price imported feed for locally manufactured feed. Subsequent technical training on proper administration of sinking feed per fish will be offered to fish farmers to improve productivity. This involves liaising with research institutes and consultants to provide training to selected entrepreneurs on fish feed production and pond management.

This type of approach focuses on particular groups (e.g., women micro-entrepreneurs or medium-scale investors) to build individual business capacities and support the development of a favourable business climate.

Benefits: Feed will be produced through locally sourced raw materials, lowering cost of feed. This will lead to lower cost of production and result in higher profit margin for these smallholder fish farmers.

Limitations: Establishment and procurement of machinery and equipment for these production units is both time and capital intensive. The timeframe to building awareness and generating effective interest will take longer than a year considering the current state of aquaculture. However, the Foundation might consider including this option in its long term plans.

Option 3: Coordinate Establishment of Demonstration Ponds[i] – Inasmuch as technological and/or organizational support can help overcome the two major constraints listed above (feed and extension support), the lack of high quality technical assistance may be the most important limiting factor in expansion of the sector in the Western coastal zone. Small producers have limited access to best practice checklists relevant to their locale. The elaboration of specific production recommendations based on practical demonstration systems would help farmers to directly improve their farming systems.

Development of production guidelines.

Only a few of the key stakeholders in aquaculture have any substantive understanding of the biological, ecological, physiochemical and economic functioning of an aquaculture system. Clear, straightforward and reliable aquaculture technology for ponds is available but needs to be packaged for use by local investors, preferably in local or highly simplified language and disseminated.

Improving Access to Finance.

To enable the sector expand, access to finance is a pre-requisite, the scope and scale of aquaculture investment needs to be considerably enhanced. There is, however, a lack of data and general information relating to aquaculture economics, which are crucial in the selection of appropriate aquaculture production systems and efficient use of inputs.

Without any project intervention, which improves access by small to medium scale farms to finance, large-scale farms will eventually take advantage of lucrative markets and productive bio-assets and infrastructure to the disadvantage of potential local and smaller-scale investors.

Using this demonstration to clearly layout the economic realities of investments in aquaculture in the six coastal districts of the Western Region will help small-scale farmers, medium-scale investors and bankers to understand the issues associated with the development of a productive aquaculture sector.

A demonstration pond is a "model" fishpond, which shows fish farmers what works, how it is done, and enables them to envision ways to incorporate these techniques on their own ponds taking cognizance of the recommendations contained in the WRCF climate change adaptation strategy. The intervention entails facilitating interactions among aquaculture value chain actors (hatcheries, feed companies, fish farmers, processors, fish mongers/buyers) using the demonstration ponds as a focal point. These ponds will be set up as a means to disseminate improved aquaculture knowledge and technologies while providing technical assistance to promote higher productivity.

Unlike Option 1, this option offers a dual opportunity for all beneficiaries to receive technical and business training and practical experience of

lessons learnt. Training will focus on pond construction, management and maintenance, feed administration and conversion ratios, record keeping and business management. The intervention will involve identifying fish farmers, youth and women associations within the selected districts and linking them with relevant stakeholders (feed companies, hatcheries, government and research agencies and aquaculture consultants) for the creation of demonstration ponds.

Benefits: This intervention does not only address majority of constraints identified in small holder farmer aquaculture production, but will also support collaboration between and amongst the main value chain actors. It also incorporates a livelihood enhancement programme aimed at the youth and women and will help shift farmers mind-set to a more commercial orientation.

Limitations: Trained farmers may not be able to fully adopt recommended technical and business practices due to limited access to credit.

WRCF selected and implement Option 3, which is more market-oriented and involves all stakeholders and is likely to have a greater economic and social impact on communities and stakeholders than the other options. The Foundation used farmer association as entry points for this option. In addition, it answers the sustainability and value for money questions of efficiency since it requires less financial inputs from WRCF and brings together all direct actors within the value chain who can keep the ball rolling during a scale up phase.

Theory of Change

- To increase productivity, profitability and competitiveness and improve their livelihoods, farmers must develop their capacities in aquaculture management through technical and business training. This will contribute to moving them from subsistence to a commercial orientation to meet high demand coming from within and outside the Region;
- When farmers and community members apply their training and knowledge to their activities and have increased productivity and profit, feed and hatchery companies will benefit immensely as farmers will buy more feed and fingerlings. These companies will therefore be motivated to participate in the project to increase their market share.

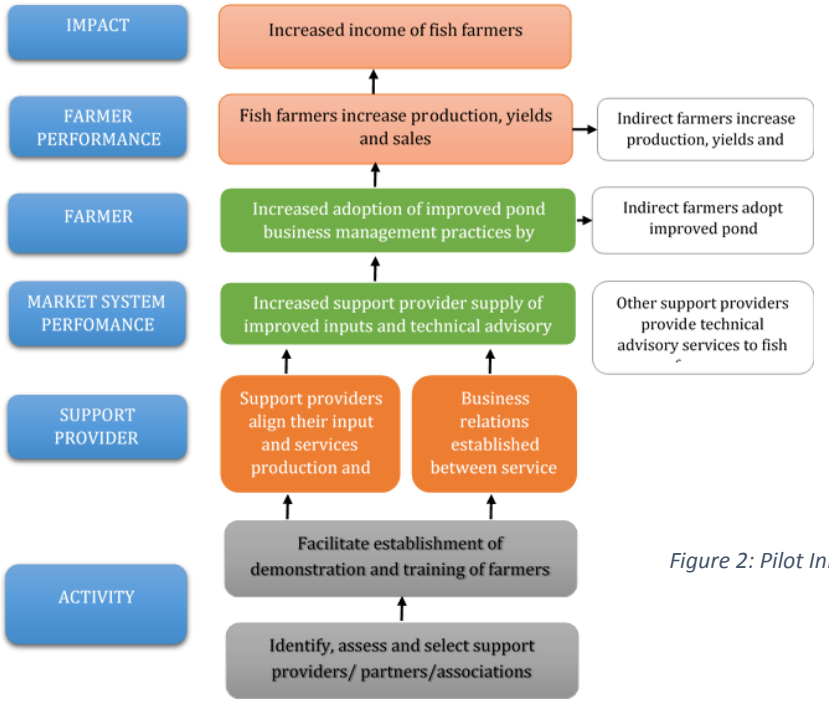
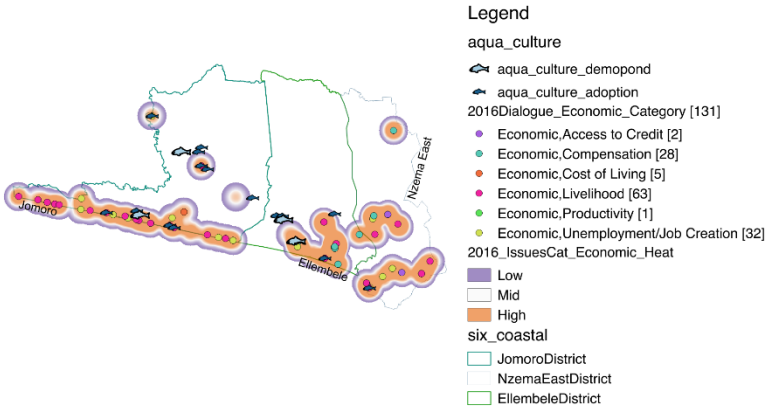


Figure 2: Pilot Initiative Results Chain

Description of the Intervention

The pilot started with identification of groups or individuals willing and able to invest time and resources to learn and adopt new technologies through training and capacity-building sessions, to enable them overcome productivity and management challenges, establishment of demonstration ponds and value chain strengthening through commercially oriented market linkages.

The beneficiaries were selected from the Jomoro, Ellembelle and Nzema East districts based on the population density of active fish farmers although they could only at best be described as operating on a subsistence level but with potential. These farmers were engaged in opportu nistic sales practises characterised by poor productivity, weak market and input linkages.



The intervention support provided support for two earthen ponds per association. To demonstrate buy in they were required to fund the cost related to refurbishment to meet recommended specifications (two ponds per association in the Jomoro and Ellembelle and one pond per association in the Nzema East District).

During the intervention, lead farmers (Trainer of Trainers) were dispatched to the Water Research Institute for in-depth training. These lead farmers provided regular mentoring to other association members during the demonstration. There is an opportunity for these lead farmers to become local consultants with the capacity to sustainably respond to demands for technical assistance in their communities.

In order to implement the demonstration ponds, the Foundation undertook the following major activities in three phases:

Phase 1: Set-up

Identification and Selection of Beneficiaries

The pilot leveraged on the WRCF Dialogue Conversation Platforms to get residents talking about activities and constraints as well as economic opportunities that engender alternative livelihoods for those most affected by the activities of the Oil, Gas and Power (OGP) companies. Negotiate agreements with selected association's members to contribute labour for the refurbishment of ponds to be used for the demonstration.

Engagement and Selection of Partners

Identified, selected, and conducted an assessment of the capacities and incentives of potential partners, namely feed companies, hatcheries, technical service providers, research institutions and government agencies. Subsequently negotiated agreements on contributions and responsibilities well as workplans and budgets.

Phase 2: Rollout

Capacity Building Programmes

- Collaborated with government and research institutions to agree to build capacity of lead farmers and association and community members on technical and business management practices
- Lead farmers and extensions officers trained to provide technical and managerial training to pond farmers.
- These lead farmers and extension officers will provide technical and managerial training in scale-ups and replications

Demonstration Pond Set Up

- Fisheries Commission provide technical oversight to the associations in the set-up of the physical infrastructure according to standards.
    - Consultants and farmers on site for training on pond construction and restructuring
    - Lead farmers support farmers on individual farms
- As part of their market penetration strategies,
    - Negotiated with feed company to provide discounts on feed for the demonstration.
    - Encourage hatcheries to sponsor procurement of quality fingerlings.
- Association members will have on the job training by lead farmers on pond management best practices namely
    - Pond maintenance(draining, water quality checks, fish separation, feed administration)
    - Record keeping and financial management
- The Foundation's monitoring and evaluation unit performed baseline data collection, mid-project data collection, and end of project data collection.

Phase 3: Knowledge dissemination

Collaborate with associations to organise demonstration pond open days to expose financial institutions, government agencies, private sector companies, other producers' associations to the demonstrations ponds.

Processes Completed To-date

Selection of pilot beneficiaries (Completed January 2016)
The process of beneficiary selection and the establishment of beneficiary baseline database is a critical factor for success from an accountability perspective. During the pilot, WRCF went through a robust beneficiary selection process. WRCF setup the intervention in Jomoro, Ellembelle and Nzema East districts based on the population density of active fish farmers. Four farmer-based groups were selected within the area, which comprised of a total of 120 fish farmers. WRCF performed the following activities before starting out the pilots:

- Met farmer based groups to discuss their concerns and expectations
- Identified particular areas of support within the selected value chain
- Identified and tested group dynamics of associations
- Validated criteria and process for selection of farmer based groups
- Undertook on-site visits to potential beneficiaries
- Mapped out steps to account for resources received

MoUs with partners (completed August 2016)

Collaborating with various stakeholders in the aquaculture value chain was another critical part of the pilot. WRCF directly engaged its key partners in the planning and implementation of the project, which contributed to the project's wider audience and increased credibility. Each partner's ability to support the project was essential to the delivery of various activities. Below is a table with the list of partners and their contribution(s) to the intervention.

Partner Category	Name	Roles	Contributions
Feed Company	Ranaan Fish Feed	Supplied fish feed for pond demonstrations at a discount; provided feed management and fingerling handling training to beneficiaries	**£2,812**
Hatchery Company	Kpemli Ventures	Supplied 8,000 fingerlings (20g each) for eight demonstration ponds at cost	**£2,500**
Associations	KAHA, Osagyefo, ANCOFFA and Al-Hamdallah Fish Farmers Associations	Contributed two ponds each for demonstration; provided pond rehabilitation labour; mobilises members for attendance at trainings and pond-side demonstrations, mobilising additional new association members to boost crowding-in effect.	**£2,333**
Research Institution (Consultant)	Water Research Institute	Providing comprehensive aquaculture expertise training to beneficiaries	
Government Agencies	Fisheries Commission	Providing extension services to fish farmers; water quality testing support; and regulatory compliance guidance support	**£423**
Input Company	Carmeuse Lime Products	Provided quick lime for pond water sanitation and de-acidification	**£167**

Establishment of Aquaculture demonstration ponds (Completed May 2016)

In partnership with the Fisheries Commission and the Water Research Institute (WRI), eight (8) sites made available by members of the four associations were designated as demonstration sites.

Association members contributed to the project by providing labour services for the reconstruction and renovation of these ponds. The beneficiary farmer who had donated his/her pond for the demonstration was to be given 40% of the total sale of fish from the association. The ponds are located in the following towns:

- Awiebo – Osagyefo Fish Farmers Association
- Kangbuli – Alhamdallah Fish farmers Association
- New Ankasa – Ankasa Conservation Fish Farmers Association
- Takinta – Half Assini/New Kabenlasuazo Fish Farmers Association

Development of catfish training manual (completed in January 2016)

To ensure continuity and sustenance of catfish farming best practices taught at the training sessions, and to share knowledge with a wider audience, WRCF, with support from the WRI, developed a catfish training manual. This manual was prepared to enhance the knowledge and hands-on skills on different stages of aquaculture enterprise. The training manual in detail covered the following areas:

- Pre-stocking Management
- Stocking Management
- Post-stocking Management
- Harvesting and Marketing

The manual provided the training facilitators and farmers with clear and customized step-by-step guidelines on various stages of production. The manual was developed through a literature review of existing training modules on similar topics and expertise of various stakeholders on the project.

Training of beneficiaries (Completed November 2016)

WRCF trained 145 farmers throughout the pilot period. Classroom training commenced one month in advance of stocking the demonstration ponds. As part of the training, farmers were taught to correctly reconstruct and restructure their ponds. Trainers summarised the training manual into local language to ensure better understanding of the farming processes.

A total number of eight classroom training sessions and 10 hands-on demonstration events were conducted from June to November 2016. Facilitators conducted monthly pond site monitoring visits to assess progress of activities taught during training. Lead farmers and association executives were given extra training on water quality monitoring for ponds, liaising with extension officers within their area to assist with water quality monitoring, implementing management practices, maintaining records, and ensuring the water

testing equipment is kept in working order. These beneficiaries became the cluster focal point persons and are still acting as "consultants" for other fish farmers within their districts.

Environmental Compliance (Completed October 2016)

Regulatory requirements for adherence to environmental compliance is pre-requisite for aquaculture. Prior to the intervention farmers had no knowledge of environmental compliance rules that existed for the enterprise. With the assistance of the Environmental Protection Authority (EPA), farmers were encouraged to ensure that their farm practices conformed to the regulations set by the Agency. A number of farmers procured EPA permits for their pond sites and were taught how to properly dispose water from their ponds.

Value Chain Strengthening (Completed March 2017)

The value chain refers to "all the activities and services – from input supply to production (capture fisheries and aquaculture farming), processing, wholesale and retail[6]. WRCF market research ascertained that the small-scale aquaculture sector, in particular, faced a series of challenges ranging from feed and fingerlings procurement to lack of technical assistance from government institutions and the marketing of final products. The knowledge gained from information collected provided an overview of the context in which the different fisheries-related businesses were operating, revealing key weaknesses in the different local and external supply chains as well as opportunities to improve the area's capacity to generate more value for and from aquaculture products.

Aiming at strengthening the value chains in the pilot area, and ensuring that these local enterprises could interact with various stakeholders related to the aquaculture system, the Foundation supported activities, which involved increasing the farmers' advantage through better organisation of sales, and strengthening activities such as processing. This created avenues where farmers could interact with various stakeholders (feed manufacturers and dealers, government institutions, hatchery operators, restaurants and hotels, catfish aggregators and processors) both within and outside the Western Region.

[6] http://www.cftdi.edu.tt/pdf/Value_chain_approaches_in_fisheries_planning_CRFM_2014.pdf

Aquaculture Results Measurement

WRCF undertook a baseline survey that served as the basis for monitoring and evaluation activities to track progress against objectives. The baseline helped provide an insight into current fish farming practices, and income earnings from the fish farming prior to the WRCF intervention. Frequent spot checks were also conducted to assess the level of adherence to good practices including proper feeding of fish, water quality testing and weighing of fish. After four months of pilot implementation, an adoption survey was undertaken to measure the rate of adoption by beneficiaries of aquaculture best practices in individual farms. Post pilot assessments of the enterprise was carried out to understand the economic viability of the aquaculture intervention in terms of input- output and cost-benefit ratios. The objective was to get credible data to inform scalability of the pilot.

Market Linkages (Completed March 2017)

A major challenge in the sector was the identification of markets and the bargaining power of farmers. To increase their bargaining power, WRCF introduced a simple technology (the monk system) to the farmers during the pilot intervention, which enabled them to control water levels and enable potential buyers to view the fish without stressing them thereby eliminating the pressure on the farmer to close the deal even if the price offer is not good.

WRCF also supported farmers by linking them to available markets. Their success in accessing these markets was because of the improved quality of fish they offered, which met market requirements, and knowledge of the multiple market channels made available to them. These factors increased the profitability of these enterprises and will assure sustainability if standards are maintained.

In the course of supporting farmers to access markets, the Foundation facilitated the development of relationships between farmers and aggregators, restaurants and hotels, processors and retailers both within and outside the Western Region. Farmers were encouraged to diversify their marketing channels through the provision of quality-smoked catfish.

Proper smoking practices were introduced to both farmers and processors to improve on product quality. Farmers also took other self-initiatives by selling their products to organisations outside their districts and grilling sample produce for prospective consumers.

Information Sharing

As a practice, WRCF see value in sharing and managing knowledge to allow stakeholders (internal and external), the opportunity to provide solutions or recommendations to issues. As a result, WRCF under took a number of activities highlight the success of the aquaculture pilot intervention, which resulted in stakeholder gaining knowledge, sharing knowledge of their experiences, and finding ways to scale-up the pilot. These activities were:

- Publishing the aquaculture training manual on the website
- Promoting implementing partners meetings: peer learning and review platform
- Undertaking various visits to demonstration ponds by various stakeholders and value chain actors
- Holding of an Aquaculture Stakeholders Learning Forum

Results of the WRCF Catfish Pilot

The theory of change supporting the overall objective of the aquaculture outlines that with farmers implementing better management and business practices and supplying to mixed channels of markets, the potential existed to achieving higher productivity, and enjoying increased incomes. The project developed, tested and demonstrated improved catfish culture technologies. The table below shows some of the intermediate results achieved.

IMPROVED FEED CONVERSION RATIO

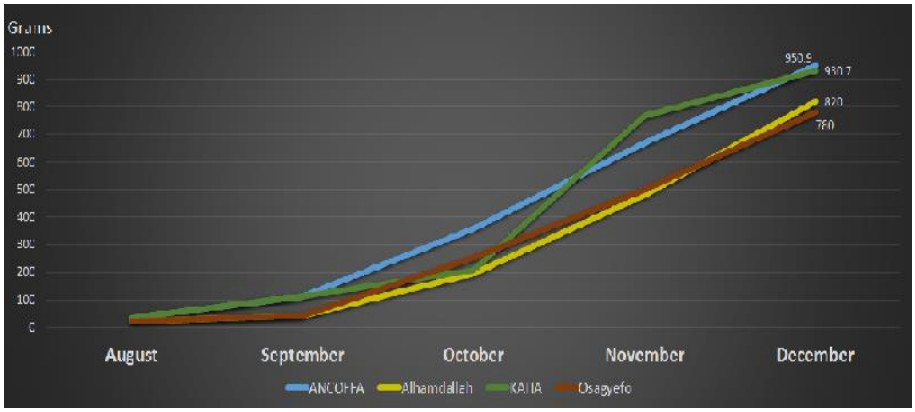
Feed Conversion Ratio (FCR) is the relationship between feed given to the fish and the weight gain of the fish. Improved feed conversion means providing less food to produce more fish. Initial data on farmers showed that feed conversion ratios (FCR) were about 4:1 meaning that 4 kilograms of feed was used to produce 1 kilogram of fish, which showed very poor feeding management and high input costs. Efficient feed management practices helped farmers to regulate feed amount, number and timing of feeding. New feeding tables were developed to reduce overfeeding and FCRs. Results from demonstration ponds showed that when farmers adhere to the correct feeding management practices, FCR dropped to 1.48:1, which falls between the recommended FCR of 1.00 to 2.00.

Parameters	Before Intervention	After Intervention
FCR	4:1	1.68:1
Mortality Rate	60%	10%
Improved stocking	5 grams	20-43 grams
Water Quality Management	N/A	Use of equipment and observation
Production Cycle	6-9months	4-5months
Behavioural Change	Subsistence	Business

REDUCED MORTALITY RATES

High catfish mortalities rates occur because of overfeeding, poor water quality management, poor fingerling management, which causes stress and fish diseases. Research by the Foundation indicated that mortality by cycle in ponds in the region is about 50% to 60% resulting in significant economic losses. At the end of the pilot period, results from the demonstration ponds revealed that mortality rates of fish has been reduced form 60% to between 10%-14%.

REDUCED PRODUCTION CYCLE TIME TO 4-5 MONTHS



Prior production cycles were between eight to ten months; however, the pilot changed this significantly and within four to six months, fish from the ponds were ready for sale. Again, this is a result of implementing good practices, which saw a faster growth for fish, with their weights averaging between 0.89kg – 1.25kg.

Feed management strategies that control how farmers feed their fish have a considerable influence upon the economic and environmental sustainability of their enterprises. Efficient feed management practices helped farmers to regulate feed amount, number and timing of feeding.

New feeding tables were developed to reduce overfeeding and FCRs. Results from demonstration ponds showed that when farmers adhere to the correct feeding management practices, FCR dropped to 1.48:1, which falls between the recommended FCR of 1.00 to 2.00.

BEHAVIOURAL CHANGE LEADS TO INCREASED PROFITABILITY

The objective of commercial fish farming is to produce fish for sale at a profit. Therefore, production should be planned from the onset to target identified markets. This means one should:

1. Have the required product (size and form) available when the market wants it,
2. Be able to produce adequate volumes to sustain targeted markets,
3. Produce at a competitive price that would not affect profit gain

Farmers gained an increase in profits because of cost savings they achieved through efficiency gains in feed conversion and reduced mortality through good water management. Results from the pilot ponds recorded a positive income over costs by all the four Associations demonstration ponds.

PRODUCTION RESULTS				
	ANCOFFA	**KAHA**	**Alhamdallah**	**Osagyefo**
Number of fish stocked	1,235	1,880	2110	1,333
Mortality rate%	5%	10%	5%	5%
Total weight (kg)	1,173.2	1,692	2,004.5	1,266.3
Average weight per fish	1.04	0.97	0.89	1.07

PROJECT COSTS AND REVENUE GENERATED				
WRCF Costs (GHC)	9,953	8,403	10,623	9,457
Partners Contributions (GHC)	5,085	5,221	4,569	3,919
Total Costs	**15,038**	**13,624**	**15,192**	**13,376**
Average price per kilo (GHC)	13	10	10	11
Value of fish consumed and donated for market linkages promotions(GHC)	3,745.34	3,303.4	5,163	1,482.9
Actual cash sales	12,117	13,109	12,677	13,422
Value of fish produced	**15,862.34**	**16.412.4**	**17,840.05**	**14,904**
Net benefits to pond	**824.34**	**1,037**	**2,648**	**1,528**

*Details of contributions in Annex Two

Given the demonstrated success of the pilot intervention, WRCF believes that there future of aquaculture in the Western Region is bright if support is given to interested community members. WRCF proposes that Oil, Gas and Power companies, mining companies, private sector players, and donors provide support to these interested residents, particularly those from communities affected one way or the other by oil and gas operations. Residents from these communities will be required to have access to land and water. This will enable them construct and operate a model size pond of 100M² with an average depth of 1 M², stocked with 530 fingerlings of 20 gram weight as a standard.

Projections from these pilot results provide a basis for developing a model enterprise budget below. The calculated IRR[7] is 16% and operating two cycles per annum at a gross profit per cycle is GHc864 plus a wage income of GHc 950. This is equivalent to an **annual increase in income** of GHC **1,814** per pond constructed and operated in the community. The required investment outlay is estimated at GHc6, 000, of which capital cost related to land acquisition and the pond construction is 50% with working capital requirements being covered by the other 50%.

[7] **Internal Rate of Return:** The IRR of an investment is the discount rate at which the Net Present value of costs of the investment equals the net present value of the benefits of the investment. The IRR rule states that if the internal rate of return (IRR) on a project or investment is greater than the– the cost of capital – then the decision would generally be to go ahead with it.

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	TOTALS
Cash Operating Expenses							
Feed	288	432	720	720	576	144	2,880
Number of 15kg bags	*4*	*6*	*10*	*10*	*8*	*2*	*40*
Fingerlings	550	-	-	-	-	-	550
Labor	300	100	100	100	100	225	925
Cycle-round, full-time equivalent (days)	*10*	*6*	*6*	*6*	*6*	*7*	*41*
Seasonal, part-time (days)	*2*					*2*	*4*
Plankton control (lime & fertilizer)	120						120
Pumping machine hire	80	-	-	40	-	80	200
Days hired	*2*	-	-	*1*	-	*2*	*5*
Transportation *(marketing, fingerlings)*	80			30	30	30	170
Repairs and maintenance							-
Water Quality Tests*	200						200
Telephone	5		5		5	10	25
Office supplies	20				10		30
Operating Costs	1,643	532	825	890	721	489	**5,100**
Depreciation (fixed costs)							
Excavation & Pond Construction	13	13	13	13	13	13	75
Drainage System	2	2	2	2	2	2	10
Monk outlet system	3	3	3	3	3	3	15
Netting *(protective, nursery, harvest)*	14	14	14	14	14	14	86
Storage shed	4	4	4	4	4	4	27
Permits	5	5	5	5	5	5	28
Depreciation	40	40	40	40	40	40	**240**
Operating + Fixed Expenses							**5,340**
Interest Expense *(lumpsum at Month 7)*							**GHC 0**
Accrued interest on variable costs							*0*
Accrued interest on fixed costs							*0*
Total Operating, Fixed & Interest Exp							**GHC 5,340**
Catfish Farm Revenue							
Cash sales (expected)				606.00	2,459.04	3,138.96	6,204.00
Accounts receivable						0	
Total revenue							**GHC 6,204**
Gross Profit							**GHC 864**
Return on Investment (ROI)							**16%**
Proportion of Variable Costs							
Feed							**56%**
Fingerlings							**11%**
Hired labour							**18%**
Feed Conversion Ration (FCR)							**1.20**
Cost per kilo of catfish							**10.72**

**Estimate from Fisheries Commission*

***Optimal FCR is 1.2:1*

Increasing Fisher Community Participation in Aquculture

Aquaculture has been suggested to be a better alternative to bridging the nation's demand for fish. The promotion of this sector would not only make available food fish for the people of Ghana, but also provide employment and income for those to be engaged in the sector.

Fishing, in coastal communities has a cultural and hereditory/personal connotation attached to the livelihood for those engaged in it. Owing to this strong bond that fishers have towards their livelihood, introduction of alternative livelihoods has been met with strong resistance in the past in many communities.

Fishermen in recent times have acknowledged the changes happening in the sector and in many communites, have even started effecting some management measures to ensure the sustainability of the industry. It is envisaged that the introduction of aquaculture to fishers would provide them access to fish; which is their preferred source of protein, and in addition a means of income.

A survey was thus undertaken in some communities to assess the current interest levels of fisherfolk towards fish farming. This was to enable the Fisheries Commission know if fishers are becoming more receptive towards the idea of alternative livelihood, which would be necessary to inform related decisions in any coastal community in the Western Region. A questionnaire was designed and administered by the Commissions's Technical staff in five (5) sampling areas.

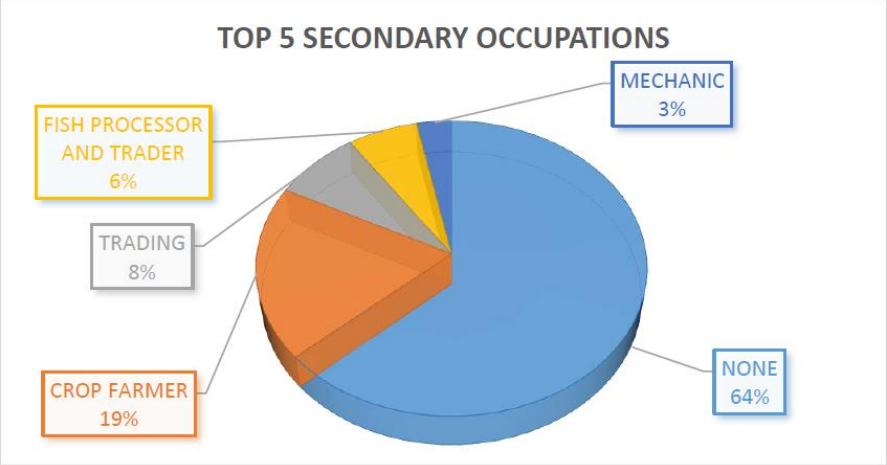
These areas are strategically towns where major fishing activities take place within the region. The questionnaires were administered between June and July, 2017 in a total of fourteen (14) communities within and surrounding these five (5) towns; the details of which are presented below:

Table 1: Details of the towns and communites where the survey was administered

S/N	FISHING TOWNS	COMMUNITIES
1	Shama	Shama Bentsir, Shama Apo, Anlo Beach
2	Sekondi	Nkontompo, Poasi, New Takoradi
3	Dixcove	Upper Dicove, Lower Dixcove
4	Axim	Apewosika Nkakemu, Bolazo, Anto Apewosika
5	Half Assini	Half Assini Fante line, Half Assini Ewe line, Ekpu

The results of the survey suggest that the primary or **current occupation** of all the 70 respondents, is tied to the fisheries industry. Fishermen were 90% followed by fish processors 6%, canoe clerk 3% and 1% beach sanitation officer.

Sixty four percent (64 %) of the respondents are not engaged in any **secondary occupation**. A total of 14 different occupations were listed from the responses, however the ranking of the summaries showed crop farming, trading, fish processing and mechanic to be the four major secondary occupations being engaged in by respondents.



In all, 18 **livelihoods of interest** were listed from the responses received. Fig. 3 above is the representation of the five major livelihoods of interest recorded. The most preferred were transport businesses and real estate. The next three in order of succession to the least were trading, aquaculture and owning a provision store.

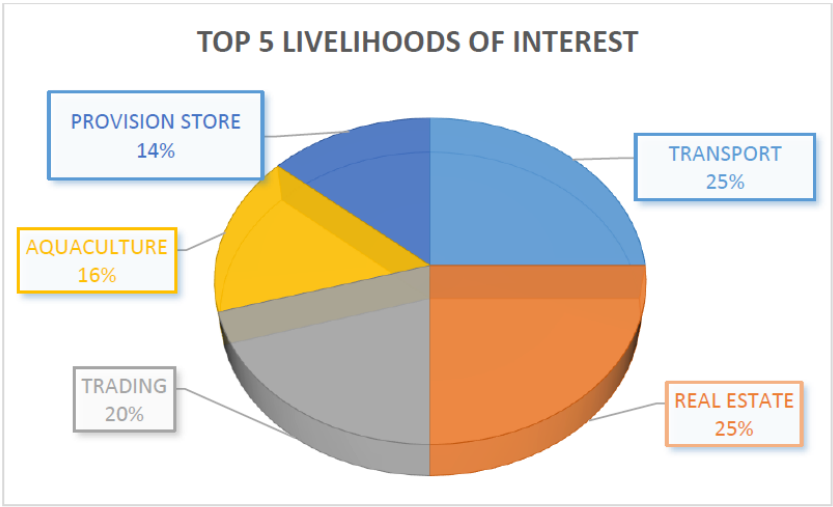
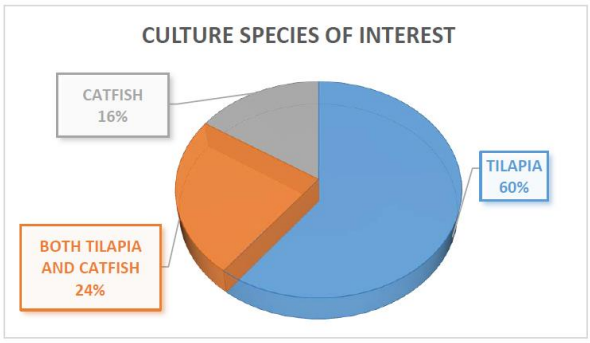


Fig. 3: Representation of respondents' top 5 livelihoods of interest

Sixty-nine (69) responses were given to the question, "**Have you heard about fish farming?**". Of the number, 64 answered "Yes" and the remaining 5 answered "No". This reflects that many fishers have received some bit of information about aquaculture.
The follow-up question, "**Are you interested in fish farming?**", received a total of sixty-seven (67) responses. Forty-three (43) answered "Yes" and the remaining 24 answered "No", showing a fair level of interest in aquaculture among members of coastal communities.



Out of the 43 respondents interested in aquaculture, 38 responded to the culture species of interest and is represented in Fig. 5 above. The popular **culture species of interest** was tilapia only. Of those remaining, more respondents would prefer to culture both tilapia and catfish than catfish only.

SCALING UP AQUACULTURE IN THE WESTERN REGION

With the significant reduction in its harvest of marine fisheries, the development of aquaculture systems is essential to food security in Ghana. Therefore, following the success demonstrated by the test pilot intervention, WRCF believes a scale-up of the pilot will further sustain the expansion of aquaculture to reach a larger number of farmers within the six coastal districts.

The concept of scale-up has been defined as "expanding, adapting and sustaining a successful technology, innovation or policy in different places and over time to reach a greater number of people." Coburn (2003) identified four dimensions of scaling up: depth, sustainability of practices after initial implementation, spread, and a shift in reform ownership[8]. Thus, she suggests that scaling-up comprises not just increased users (spread), but also long-term changes in practice and belief (depth), continuation of intervention effects after initial implementation (sustainability), and strong ownership of the reform by beneficiaries.

To ensure aquaculture is sustainable in the Western Region, thereby creating a hub, WRCF recognises the need to extend the pilot's successful innovations and concepts to new areas, involve more farmers from across the six coastal districts, guided by lessons from the pilot to stimulate aquaculture development in the Region.

There are still lingering challenges that could have direct effect on the enterprise's profitability. While WRCF attempted to address them during the pilot, we plan to implement strategies in the scale up that will focus on improving the sustainability of small-scale fish farming systems, which will increase the adoption rate of responsible farming practices. Feed is the major operational cost for most fish farms, accounting for 50-70% of the variable cost depending on farming intensity.

The rising cost of commercial catfish feed is inducing some farmers to opt for alternative feeds. Some rotate commercial feed with kitchen and restaurant waste or chicken or fish by-products, which affect the quality of fish produced. Although fish farmers have increased efficiency through proper feeding management practices during pilot intervention, cost of imported feed still rises, increasing the cost of production[9].

The scale up project, informed by the pilot intervention, identified six components that support the expansion and development of aquaculture in the Western Region.

- Extension of capacity building and information sharing to fish farmers within the region
- Development of farm-made catfish feed and training of farmers in preparation of farm-made catfish grower feed to reduce cost of production
- Extension of support to pilot beneficiaries to catalyse production
- Promotion of cage culture for the production of tilapia
- Advocacy for support from industry to fund aquaculture project

[8] Rethinking scale: Moving beyond numbers to deep and lasting change

Component 1

Expansion of capacity building and information sharing to fish farmers within the region
This component seeks increase number of aquaculture trainees from 145 to 350 by 2019 and to bridge the poor extension system gap currently provided by the Fisheries Commission and increase the number of trainings and expand to other districts. This will be done through building the knowledge of selected fish farmers by providing in-depth aquaculture expertise training (hatchery and production), improve on their training skills and develop materials to be used during the training.

These farmers will in turn provide aquaculture extension support and services and trainings to farmers in other districts. Currently, some beneficiary farmers from pilot intervention have taken the initiative and are acting as paid local consultants in their locality. However, there are various technologies that the trainers lacked information on and will need to be exposed to. Thus, the knowledge and experience coupled with their motivation, good attitude and desire to improve their communities makes them suitable candidates for capacity building to deliver the relevant information and knowledge.

Trainers will increase their income through trainings organised by WRCF and acting as paid extension service providers to other farmers within their locations. Trainings will be supervised and follow-up of farmer trainer activities will be monitored to ensuring the quality of information disseminated by the farmer trainers.

COMPONENT 1: Expansion of Capacity Building to Fish farmers
Assess farmers' capacity to effectively disseminate information
Conduct training of training of trainer's
Extend aquaculture trainings to other locations
Trained farmers linkages to financial institutions and markets
Link farmers trainers to other service providers and knowledge centres

Component 2

Development of farm-made catfish feed and training of farmers in preparation of grower feed to reduce cost of production.
The goal of this component is to train and support fish farmers in using locally available ingredients to produce and use nutritionally balanced farm-made catfish grower feed as supplement in catfish production so as to cut down on fish production cost by using farm-made feeds as against the use of expensive commercial ones. Some beneficiaries farmers have already

acquired some equipment to produce locally manufactured feed but still lack knowledge on right proportion, application and raw materials they can use.

The Problem. Most of the feed found in Ghana are imported, therefore pricing is affected mostly by the exchange rate of the local currency (Ghana cedis, GHS) to the US dollar. Although, there is a major local fish feed producing company, *Raanan*, most farmers are unable to afford its cost. Hence, majority of these farmers have folded up.

According to WRCF's post pilot assessments, a high number of farmers have identified cost of feed as a barrier to technology adoption. Feed is constitutes 50-70% cost in aquaculture production and the constant rise in the cost of feed poses a challenge to small scale fish farmers in the region. Identifying locally available ingredients to formulate feed that is nutritious but cheaper than existing commercial feeds promises productivity.

The Solution. A comparative study developed comparing tilapia feed with that of commonly used commercial ones (RAANAN and COPPENS) indicated that in terms of cost effectiveness, the former was more profitable[10]. The results indicated that nutritionally balanced farm-made fish feed is cost-effective and will boost growth of aquaculture in rural areas where semi-intensive pond aquaculture is practised in Ghana. This is likely to increase the profit margin of the farmers to over four hundred percent of what they are making currently using commercial fish feeds. However, low-cost fish feed formulated from locally available ingredients should be nutritionally comparable with good quality commercial tilapia feed to maintain productivity.

COMPONENT 2: Development Of Farm-Made Catfish Feed And Training Of Farmers
Survey and sampling of locally available feed ingredients in the Western Region
Proximate analyses of selected ingredients.
Formulation, preparation of African catfish grower feed and their proximate analyses.
Feeding trials of the African catfish with the prepared feed
Training of fish farmers on the selection of ingredients, formulation and preparation of farm-made African catfish grower feeds

[10] Evaluation of Farm-made and Commercial Tilapia Diets for Small-scale Hapa Production of Nile Tilapia (*Oreochromis niloticus* L.) in Ghana

Component 3

Extension of support to pilot beneficiaries to catalyse production
After the pilot and demonstration cycle, surveys were conducted to assess the number of beneficiaries who have been able to adopt aquaculture best practices, assess the current status of technology application among these pond owners and identify areas that requires further support to ensure sustainability. These include adoption of techniques in pond construction improved records keeping on feed, water quality, fish mortality, stocking and feeding management.

Seven months after the pilot and demonstration cycle, WRCF assessed the number of beneficiaries who have been able to adopt aquaculture best practices, assess the current status of technology application among these pond owners and identify areas that requires further support. Results from the survey showed 39 out of the 130 farmers (30%) trained under the aquaculture demonstration have currently adopted the improved technologies including pond construction (monk and dike construction, pond shaping, measurement); Improved records keeping on feed, water quality, fish mortality and other input and revenue records; Stocking management (pond stocking, sorting and grading) and Post Stocking Management (feeding and water quality management).14 (35.8%) of these people are farmers who were already into fish farming before the training, 16 (41%) were farmers who had abandoned their ponds and 9 (23%) were new farmers new to the aquaculture business.

Whilst majority of the farmers demonstrated clear understanding of the technologies, limited access to funding to cover total feeding costs will limit their application of technologies. Whilst, Associations have taken steps to manage this constraint among their members by providing feed for some members on credit basis, 91% of farmers indicated that feed subsidy for the first cycle will enable them have a running enterprise.

To effectively increase rate adoption of technologies, The Foundation will provide support, mainly through subsidies for feed inputs and on-farm feed production for the farmers through the first cycle of production.

COMPONENT 3: *Extension of support to pilot beneficiaries to catalyse production*
Assess level of adoption
Monitor farmers' pond management activity
Provide feed subsidy to farmers who have stocked ponds
Monitor progress for next stocking cycle to ensure sustainability

Conclusions

There is opportunity for introducing aquaculture as an additional income stream to a limited number of persons living in some of these fishing communities given their expressed interest. Support for these persons to successfully start and run a fish farm business either using earthen ponds or the fish tank methods close to their homes could serve as the demonstration point to encourage some other members of the communities to follow suite.

Example of a fish tank

The youth and females in the communities could be targeted for support provided they demonstrate some commitment to invest time and some resource to this experiment.

WRCF is looking for partners in the Oil and Gas Industry to pilot a 2 cultured fish initiatives in each of the 14 survey communities as an alternative livelihood opportunity targeting youth and women who exhibit and entrepreneurial spirit.

ANNEX ONE

TECHNICAL AND FINANCIAL CASE

Culture system	Unit Size	Estimated Unit Cost (GH₵)	Expected stocking/Fingerlings*	Expected weight harvest**
Plastic / fibre glass / Metal tanks[11]	1000 litres container i.e. 900 litres production (1.4x0.8x1 m)	500.00	53	45 kg of fish
Polygon ponds (Circular Tarpaulin tanks) [a] Poly tank[12]	5,000 litres 5,000 litres	2,450.00 1,500.00	267 267	250 kg 250 kg
Tarpaulin Tank (Locally fabricated with metal frame and installation)[13]	(4x1.2x0.9 m) 4.8 m² (6x1.2x0.9 m) 7.2 m² (6x3x1.0 m) 18 m²	1,500.00 2,200.00 5,000.00	152 227 567	144 kg 216 kg 540 kg
Cover mesh netting	2" stroke 18 ($^1/_4$ bundle)	110.00		
Water quality monitoring	Twice per production	410.00		
Simple aquarium pump / aerator	1 set with 4 hose (5-10 watts power/day)	300.00		

*Stocking density can be increased by 20% - 40% based on management practices and rate of water exchange based on water quality and available (site visit and feasibility makes it site, system, management dependent). Calculation are based on a 5% mortality rate from WRCF pilot Aquaculture intervention in earthen ponds.

**Based on Harvestable or preferred size of 750g – 1000 g (1kg), the stocking density can be increased if smaller sizes of fish are needed.

[11] Re-use tanks as indicated in picture 1

[12] Imported durable set indicated in picture 2

[13] Local fabricated in Ghana as indicated in picture 3

Picture 1: 1000 litres (250 gal.) Plastic / fibre glass / Metal tanks

Picture 2: Polygon ponds (Circular Tarpaulin tanks) with inlets and outlets

Picture 3: Tarpaulin Tank (Locally fabricated with wooden frame)

ANNEX TWO

PARTNER CONTRIBUTION DETAILS				
WRCF COSTS	**9,953**	**8,403**	**10,623**	**9,457**
Feed	9,238	7,688	9,548	8,742
Fingerlings Transportation	150	150	150	150
Office Supply	45	45	45	45
Pond Reconstruction(Amortized)	520	520	520	520
PARTNER CONTRIBUTION	**5,085**	**5,221**	**4,569**	**3,919**
Kpemli Farms (Fingerlings)	1,359	1,880	1,333	1,466
Beneficiaries (Labour)	1,775	1,775	1,775	1,775
Carmeuse Lime (Lime)	226	226	226	226
Beneficiaries (Transportation)	530	430	100	100
Beneficiaries (Pumps)	440	280		160
Fisheries Commission (Water Quality Test)	600	600	400	600
Beneficiaries (Communication)	45	45	45	45