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Research Article

Aquaculture Development and Uganda's Agricultural Extension System: The Case of Fish Farmers in Central and Northern Regions

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Abstract

Agricultural extension services are critical to the development of crops, livestock and fish farming in order to bring about social change. Fish farming, though introduced over 50 years ago through research and extension, remains at a slow pace of growth. There is a consensus in academic and policy literature about the potential benefits of fish farming, particularly nutrition and income generation. So why has extension not been more successful in improving the status of fish farming? Most explanations focus on supply side issues highlighting lack of inputs, particularly fingerlings and feeds with little consideration given to how the extension services themselves are organized in view of fish farming under general agriculture. Equally absent in the discourse are the perspectives on the motivations and experiences of individual fish farmers. Drawing from the Actor Oriented Perspective, this paper examines the organization and current status of extension service provision in aquaculture based on perspectives of policy makers, extension workers and fish farmers. Interviews were conducted with 246 fish farmers, eight extension workers and 11 key informants from government institutions. Secondary sources of information included various government documents on agriculture. Results revealed slow growth of aquaculture due to institutional and social factors regarding alignment of extension service provision to the needs of fish farmers. Reforms instituted over the past decades in search of better ways to avail farmers with improved farming knowledge have had minimal success. Less than 50% of fish farmers received extension visits from district extension staff with moderate difference ($p<0.05$) between frequency of extension visits in central and northern regions. Bias of extension service provision towards production related technical and information aspects above building and strengthening social capital of fish farmers was noted. Extension interventions should be socially negotiated and adapted in view of aspirations and limitations of fish farmers.

Keywords: Agricultural Extension; Aquaculture; Fish Farmers; Policy; Uganda

Introduction

Fish production through aquaculture presents an opportunity to circumvent the global challenge of declining stocks from the natural water bodies due to overfishing. The demand for fish outweighs supply amidst growing populations. Raising fish production to levels that can match demand for fish requires the provision of effective extension services to fish farmers. Aquaculture, introduced in Uganda through research and extension interventions during the early 1950s, is a practice that involves rearing fish and other aquatic organisms in controlled facilities for food and economic benefits [1,2]. Fish farming plays a key role in food security and improving livelihoods [3]. The introduction of aquaculture in Uganda aimed at ensuring access to fish by rural households. Fish is an important source of protein that is not easily accessible by communities located far away from natural water bodies or urban centers where outlets for marketing food stuffs are fairly established. In addition to providing nutritional benefits, fish farming has potential to meet the demand for fish, alleviate pressure from the overfished wild stocks and contribute to livelihoods through employment and income generated from fish sales [4,5]. The Food and Agricultural Organization (FAO) observes that for over 50

years, the growth of fish farming in Sub-Saharan Africa has however remained low, contributing 0.7% to total fish production [6]. Reasons underlying this scenario are not clearly known but seem to point to impacts of the agricultural extension approaches and system used overtime in relation to the extension needs of fish farmers. The approaches include participatory approaches through farmer groups [7-13] that reveal mixed results in meeting needs of farmers.

In Uganda, provision of extension services to farmers has been based on policy frameworks informed by development paradigms and donor funding arrangements. Different extension approaches have been used to provide services to farmers. In addition to crop and livestock production, interventions to ensure development of aquaculture fall under the mandate of the Ministry of Agriculture Animal Industry and Fisheries (MAAIF) [14]. Among these interventions is the extension service provision, the topical issue of this paper. The purpose of agricultural extension is to provide knowledge, skills and other services needed by farmers to improve productivity and general socio-economic wellbeing of household members. This therefore implies that the central feature to any extension system and approach should be thorough understanding of the needs of farmers.

There is a general consensus in academic and policy literature about the potential benefits of fish farming, particularly nutrition and income generation. Attainment of these benefits was the rationale for the introduction of fish farming in Sub-Saharan Africa and Uganda in particular by colonial governments [15]. A study by the National Agricultural Research Organization (NARO) and MAAIF (2000), [16] conducted as a baseline for a Department for International Development (DfID) project, documents the status of fish farming and shows the majority of fish farmers operated at subsistence level in small fish ponds of average 200m^2 producing less than 1kg per hectare.

Low productivity is attributed to use of poor quality inputs, particularly fish feeds that largely include locally available materials such as vegetable leaves instead of using the factory manufactured complete diet fish feed. Consequently, the contribution of aquaculture to household nutrition and income remains minimal [17,4]. In addition, analysis of the profitability of small-scale fish farming shows low positive returns with predators and high cost of feeds as the major constraints [18]. Yet, [19] observe that efficient use of resources and higher yields can be achieved from accessing extension services. So why has extension for fish farming not been more successful? Most explanations of underdevelopment of fish farming focus on supply side issues highlighting lack of inputs such as seed (fingerlings) and feeds. Yet, little consideration is given to how the extension services themselves are organized in view of fish farming under general agriculture. Equally absent in the discourse are the perspectives on the motivations and experiences of individual fish farmers.

Drawing from the Actor-Oriented Perspective [20], this paper explores the introduction of fish farming in Uganda and highlights actor interactions in extension interventions. Long's perspective focuses on concepts central to development work intended to bring about social change. According to the perspective, intervention should be an on-going socially constructed process and not a mere execution of already-specified plan of action with expected outcomes. In this paper, the perspective is used to assess the implementation of agricultural extension models with regard to needs of fish farmers. Furthermore, a thorough understanding of the 'lived worlds' of actors in fish farming amidst institutional interventions in extension service delivery is examined. Specifically, the paper uses information from analysis of historical trends that have shaped the development and up-take of aquaculture through various government interventions. Linked to this analysis is an account of the socio-demographic characteristics of fish farming households in relation to institutional mechanisms and processes in the extension service provision.

Materials and Methods

The study was carried out between January 2015 to March 2016 in selected districts in central and northern Uganda (Figure 1). In the central region, five districts were selected (Bukomansimbi, Kalungu, Lwengo, Masaka and Mpigi) while in the north three districts were selected (Alebtong, Kole and Lira). The wetter, cooler, eroded, bush-covered lands bordering Lake Victoria are around 1,300 meters in elevation. The northern districts are tree savanna, warmer, drier, at lower elevation, and are less densely populated. The two regions vary in terms of climatic conditions, socio-economic status and cultural practices of the people that may influence engagement in fish farming. Selection of the two regions was thus purposive with intention to generate results that complement and compare with each other.

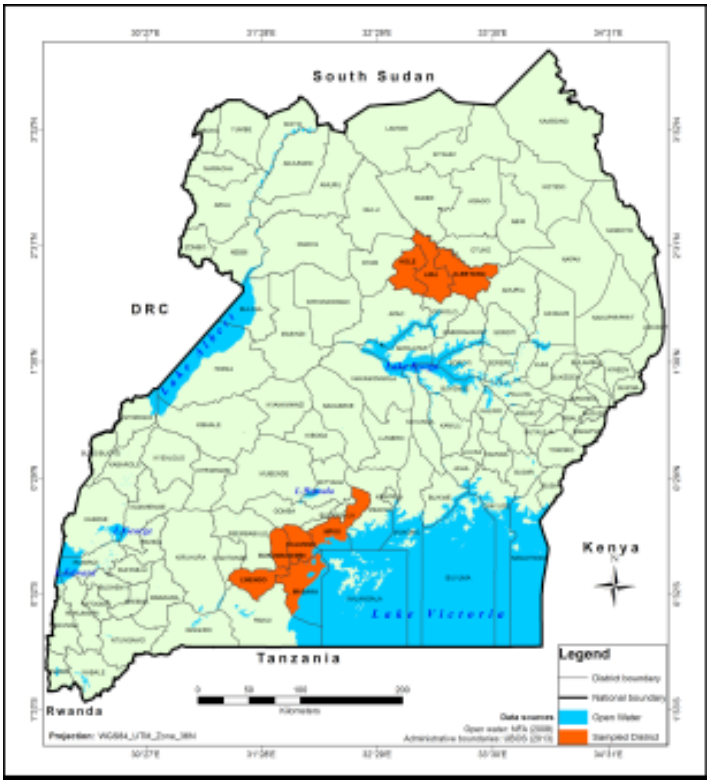

Figure 1: Map of Uganda showing districts covered during the study.

The study used a mixed methods study design [21] that involves combining quantitative and qualitative research techniques [22]. The design enables collection of data from a wide range of sources and carrying out necessary in-depth inquiry. Due to unavailability of reliable sampling frames, area sampling was used to select the districts. Every fish farmer known to the fisheries extension worker and other fish farmers in each district were included in the study until the sample size for the survey was attained.

The sample size for the estimated population was calculated using a formula in [23] generating a total of 246 fish farming households. The sample comprised 100 fish farmers from the five districts selected from the central and 146 fish farmers from the three districts selected from the north. Data collection involved a desk study (review of relevant documents), Key Informant Interviews (KIIs) and Focused Group Discussions (FGDs) with purposively selected documents and respondents. Using a semi-structured interview schedule, the survey covered 246 fish farming households. The review of documents focused on information about policy issues, strategic plans, reforms in the agricultural sector and development of fish farming in the country.

Data from the survey were analyzed using the Statistical Package for the Social Sciences (SPSS version 21). Descriptive statistics were used to present demographic and socio-economic characteristics of fish farmers, level of engagement in fish farming and extension service provision. Data recorded during FGDs and KIIs were transcribed to create text-based electronic format and organized for analysis. Using ATLAS.ti, the data were processed by assigning data segments to particular codes, and analyzed and interpreted according to questions under investigation. Thematic analysis of data from documents was carried out manually tracking the historical trend of fish farming, including extension service provision to fish farmers.

Results and Discussion

Historical Overview of Aquaculture Development

Based on available records in the literature [15,24,25] and results from KIIs, (Table 1) highlights features of extension that have characterized fish farming in Uganda from the early 1950s.

Period	Features of extension with regard to aquaculture
1953	Establishment of the Kajjansi Fish Farm with the aim to demonstrate fish farming practices/technologies to Ugandans.
1960s	Introduction of different fish species for fish culture and realisation of the need to carry out experiments, trials, investigations to adopt the practices to local conditions. A laboratory was constructed and experiments on culture of various fish species started. Establishment of fish fry centres in each of the four regions for production and distribution of species and hybrids found suitable for fish farming fry to fish farmers. Specific activities of Kajjansi station included selection of sites, planning layout, supplying and stocking fish, feeding and sampling during the rearing period and harvesting. The original extension services were thus fully government funded, including free fry/fingerlings and pond fishing gear/nets. Essentially, the farmers were totally dependent on government for all fish farming inputs. Kajjansi station also had the role of training farmers and extension workers. External technical support was provided by experts from FAO to carry out specific experiments, conduct training for staff and farmers, and promote extension of fish farming across the country. Tremendous growth in the number of fish farmers and fishponds from 5000 in 1959 to 11000 by 1968 producing about 900 tonnes of fish annually [26].
1970s-80s	Political crisis and civil war leading to breakdown of economy. Total decline in all aspects of aquaculture development. Regional fry centres were run down, leaving Kajjansi operating at minimum capacity, farmers abandoned fishponds due to lack of fry and outreach activities by extension staff [25].

1990s	The Agricultural Extension Project (AEP) initiated as part of the reconstruction process following return of political stability; strengthening the delivery of extension services was one of the components. Prior to 1992, agricultural extension was sector specific and independently carried out by four ministries, yet all addressed issues of the same farmer practicing mixed farming. The scenario was like three or four specialised extension workers converging on one farmer with different messages at different times. To address deterioration and fragmentation of public agricultural research and extension services, the two ministries responsible for crops, livestock and fisheries amalgamated in 1991 to form MAAIF. In 1992 research programmes were merged to form NARO. Kajjansi Experimentation Station transferred to NARO. Agricultural extension and research consolidated into a single unified national system within MAAIF. Alongside AEP, additional support to aquaculture research and extension was from DFID from 1999-2004. The Lake Victoria Environment Project (LVEMP) implemented from 1998 to 2006 but with less focus on aquaculture compared to other components. Effect of LVEMP project on productivity of aquaculture remained unclear since only number of fishponds established and stocked was reported [27]. LVEMP Project implementation rated unsatisfactory [28].The link between research, extension and farmer linkages remained weak under the AEP and the unified agricultural extension.
2000-2009	A series of activities preceding extension major reform aimed at involving farmers in decisions regarding provision of extension services. In 2001, National Agricultural Advisory Services (NAADS) Bill passed by Parliament and NAADS Secretariat established as a corporate body in charge of agricultural advisory services. Phased introduction of the NAADS programme linked to broader decentralisation of capacity-building initiatives, initially in 6 trail-blazing districts. Farmer groups as main entry point for providing advisory services but the approach not favourable to fish farmers. Almost no farmer group comprised a critical number of farmers to push fish farming on the priority list through majority vote as per NAADS criteria for enterprise selection. Limited extension service provision to fish farmers mainly by non-NAADS supported district extension staff and a few private extension workers. Due to growing commercial aquaculture enterprises amidst limited government extension workers, unregulated private service providers emerged.
2010 to-date	Phase 2 of NAADS known as Agricultural Technology and Agribusiness Services (ATAAS) effective 2012 and implemented by MAAIF through NARO and NAADS. ATAAS sought to address the weak linkage between the different actors involved in agriculture, particularly research and advisory services. Another era of reforms in the agriculture sector concluded in 2015. Inter-ministerial technical committee on restructuring agricultural extension agrees to an integrated "Single Spine" extension system as proposed by MAAIF [29]. National Agriculture policy with the mission to "Transform subsistence farming to sustainable commercial agriculture" is formed [30]. NAADS is reformed and the Directorate of Agricultural Extension Services is created at MAAIF to manage and coordinate delivery of extension services countrywide [31,32]. In order to regulate various aquaculture service providers to ensure quality services for fish farmers, the Department of Aquaculture Management and Development of MAAIF develops guidelines for aquaculture service providers [33].

Table 1: Aquaculture development and extension since the 1950s.

For the case of aquaculture, extension service delivery to farmers was a domain of researchers and extension staff because fish farming was new, and the main source of knowledge were government officials working at the experimental fish farm established at Kajjansi since 1953 [15,25]. During the 1960s, fish breeding and fry production centers were established in each of the four regions of Uganda in order to ensure easy access of fry for stocking farmers' ponds. In addition, demonstration ponds were established at selected sub-county headquarters and schools.

The number of farmers engaging in fish farming grew due to increased fry production and distribution to farmers by government. Besides carrying out research, Kajjansi station provided extension services to farmers that include selection of sites, planning layout, supplying fingerlings, feeding and sampling during the rearing period and harvesting. The fish farmers were therefore entirely depended on extension staff and activities were planned and executed to the convenience of the extension staff rather than the farmers in a top-down supply-driven activity. Although the number of fishponds increased tremendously by the late 1960s, productivity was generally low and varied greatly, ranging from 35 to 1000 kg/ha/yr. Factors for low productivity included poor pond site selection, unsatisfactory layout and construction, too small ponds, poor growth of tilapia species and inadequate knowledge of proper pond management practices.

Despite low productivity and inadequate farmer skills, extension service delivery continued to expand throughout the 1960s. The 1970s to early 1980s were characterized by political instability, including armed conflict that led to the deterioration of production of fish fry to stock ponds and to conduct outreach activities for fish farmers. Hence, there was a shortage of fry to stock farmers' ponds amidst reduced regular re-training sessions for extension workers. In addition, research gradually decreased at Kajjansi and at the regional fry centers, including extension activities for farmers. The social and economic breakdown due to political crisis set in at a time when fish farmers were completely dependent on government for fish farming inputs and equipment like nets. Farmers lacked the technical capacity to do even basic activities on their own such as harvesting fish from ponds.

As part of a new political regime from 1986, the need to increase agricultural productivity was one of the government priorities as a strategy to rebuild the economy. Focus was on key functions in the agricultural sector, namely research and extension. The Agricultural Extension Project was implemented with support from the World Bank from 1992 to 1998. The broad objective of the project was to address urgent needs for disease control and yield improvements, and to build public sector capacity to deliver and support effective extension services. The project supported a consolidation of several parallel programs that publicly provided extension services. The programs existed and operated across several ministries, including Ministry of Agriculture, Ministry of Animal Industry and Fisheries, Ministry of Energy, Minerals, Water and Environment Protection, Ministry of Commerce, Industry, Cooperatives and Marketing. As a result, the Ministry of Agriculture and the Ministry of Animal Industry and Fisheries were merged to form MAAIF, and the overall responsibility for agricultural extension, like that for agricultural research was consolidated into a single unified national system. Unifying agricultural extension was intended to be a multi-enterprise action oriented just like the farmers. Likewise, disjointed agricultural research was also brought under one umbrella, the NARO.

Despite the positive steps to streamline agricultural extension and research, implementation of the project did not satisfactorily meet intended objectives. Information obtained from KII revealed the most significant weakness of unified extension as the attempt to train (through short training courses) extension workers specialized in crops, livestock, fisheries or forestry to provide technical advice in different fields from their professional training. Due to lack of sufficient knowledge, extension workers tended to concentrate on their specialized areas where they were more confident and probably had more interest, at the cost of the other sectors.

Other factors that severely affected project implementation included inadequate counterpart institutional and financial support from government, and public sector restructuring and decentralization that reduced the number of extension staff [28]. As the project got closer to the end, new global thinking and paradigm shift from bureaucratic top-down and supply-driven approaches to extension service delivery to decentralized, participatory and demand-driven approaches was emerging and being fronted [34]. The NAADS program was formulated along such ideas following a report by a government task force on agricultural extension.

The NAADS was created by an Act of Parliament and launched in 2001 as a semi-autonomous institution under the Ministry of Agriculture Animal Industry and Fisheries with responsibility for ensuring access to agricultural knowledge, information and technology by farmers. Implementation of NAADS was in line with on-going national policy frameworks aimed at deepening decentralization of service delivery and poverty alleviation, and transforming agriculture from subsistence to commercial level. Under NAADS, interventions by MAAIF to commercialize agriculture, and in this case aquaculture through supply of free seed and feed, did not improve production and productivity as supplies lacked accompanying technical advice. Institutional considerations, particularly budget allocation and staff capacity, at central and local government levels for effective extension service delivery were not wholly incorporated. Failure of NAADS to fully integrate with existing underfunded decentralized extension service within the districts created a semblance of two parallel extension delivery systems that were in conflict [35], a situation that alienated fish farmers from accessing extension services.

Subsequent reform of NAADS created the Directorate of Agricultural Extension Services under MAAIF to coordinate delivery of agricultural extension services country-wide. In addition, a policy guide that spells out implementation arrangements including roles and responsibilities of different stakeholders was developed [31]. In line with the new agricultural policy, a "single spine" extension system brings all extension staff under a single regulatory body (MAAIF) and advocates for stronger linkages with research, educational and farmer institutions for effective agricultural services delivery to farmers.

The revised structure also caters for staff positions of all the subsectors including fisheries officers in charge of aquaculture at district and sub-county levels. With the reform undertaken so far, it is still not yet clear whether aquaculture will receive the appropriate extension support it has lacked over the years. However, there is optimism for improved service delivery following the decision and commitment by MAAIF to streamline and regulate service provision to fish farmers. These interventions are based on reported growth of aquaculture as indicated by an estimated increase in production from 285 to 100000 tons between 1999 and 2016 [33].

Status of Fish Farming in The Study Area

Fish farming in Uganda is largely undertaken as one of the diverse household agricultural enterprises. Mixed farming has been practiced from the 1950s when fish farming was introduced among Ugandan farmers as an appendage to the already existing farming activities at the household level. The study showed that in the majority of cases, fish farming was carried out as a secondary activity while at the same time taking advantage of using swamps, often not suitable for other agricultural activities. The overall driving factor for engagement in fish farming was the need to generate additional income for the household.

Fish Species Reared

The Nile Tilapia (*Oreochromis niloticus*) (known as "engege" in central Uganda and "lut" in northern Uganda) and African catfish (*Clarias gariepinus*) (also known as "emale" in central Uganda and "twang" in northern Uganda) were the predominant fish species reared by farmers mainly in earthen ponds. Culture of the two species followed results from initial experiments carried out during the introduction of fish farming in Uganda where indigenous and non-indigenous species were tried [15]. Government interventions in fish farming have since promoted adoption of Tilapia and Catfish because of ease adaptability to culture conditions. Besides, the species can be grown together in a particular system such as a

fish pond. Slightly more than 70 percent of the fish farmers reared Tilapia while 56.9% reared African catfish.

Profile of Fish Farmers

This section provides analysis of selected demographic and socio-economic characteristics of fish farmers in the study area. In addition, the section provides information on the fish ponds operated by farmers and fish farming characteristics. The results are disaggregated according to the central and northern regions where data collection was carried out among pond fish farmers.

		Sampled Regions		Total Sample n=246 %
		Central n=100 %	North n=146 %	
Demographic and socio-economic characteristics of respondents				
a) Gender of household head	Male	91.0	95.9	93.9
	Female	9.0	4.1	6.1
b) Education level of household head	Never attended	3.0	4.8	4.1
	Primary	33.0	43.2	39.0
	Secondary	32.0	35.6	36.6
	Certificate/Diploma	16.0	8.1	11.4
	Degree	10.0	8.0	8.9
c) Occupation of household head	Farming	78.0	89.0	84.6
	Business/Trading	10.0	1.4	4.9
	Public service	10.0	6.8	8.1
	Other	2.0	2.7	2.4
d) Total household income in past 12 months (million shillings)	Up to 0.5m	13.0	21.2	17.9
	>0.5m - 1m	4.0	12.3	8.9
	>1m - 1.5m	9.0	15.8	13.0
	>1.5m - 2m	7.0	9.6	8.5
	>2m	67.0	41.1	51.6
Fish ponds and fish farming characteristics				
e) Land owned (hectares)	0-10	85.0	90.4	88.2
	11-20	8.0	6.2	6.9
	>20	7.0	3.5	4.8
f) Number of fish ponds	1-3	80.0	84.9	82.9
	4-6	16.0	13.0	14.2
	7-9	2.0	2.1	2.0
	10-12	2.0	0.0	0.8
g) Total pond area (m^2) operated by household	<1000	36.0	71.9	57.2
	1000 – 1999	21.0	15.1	17.5
	≥2000	43.0	13.0	25.2

Table 2: Demographic, socio-economic and fish farming characteristics of sampled respondents, 246 Uganda fish farming households, 2016.

The most significant demographic and socio-economic characteristics of fish farmers in both study areas were sex, education level and income status. Households engaged in fish farming were headed by married males with most of them in the middle age groups between 39 and 68 years. Close to 60 percent of respondents had secondary level of education and above while 4% did not undergo formal schooling. In relation to extension service provision, educational levels of the respondents suggest that majority of fish farmers can competently access and comprehend print messages and instructions. Income from fish farming contributed 15% to total annual household income with majority of households earning over UGX 2 million (1UGX = 3640).

In terms of access to land, the majority (80.1%) of respondents owned land ranging from 1 to 15 acres. There was no statistically significant difference in size of land owned across the central and northern regions. Farming was the main occupation of the household head (84.6%), involving growing crops such as cassava, maize and coffee and rearing of cattle, chicken goats and pigs. Apart from farming, most respondents engaged in trading of various items as the main non-farm livelihood activity to supplement incomes.

Ownership of The Fish Farm Enterprise

Fish farming remains a male dominated activity with over 90 percent ownership of the fish farm enterprise. The female household heads (6.1%) interviewed during the study were widows and owned the fish farm enterprises indicating rights held over property in matrimonial households. In terms of experience in fish farming, majority of respondents (39.8%) started fish farming within the past five years implying that fish farmers do not have long experience in fish farming. Furthermore, this scenario implies that fish farming continues to attract new entrants who need proper guidance on how to manage the enterprise effectively. The results further indicate that over the past five years, more farmers in the central region are joining fish farming compared to northern region, though the difference is not statistically significant. Overall, these results reflect growing interest in fish farming by farmers.

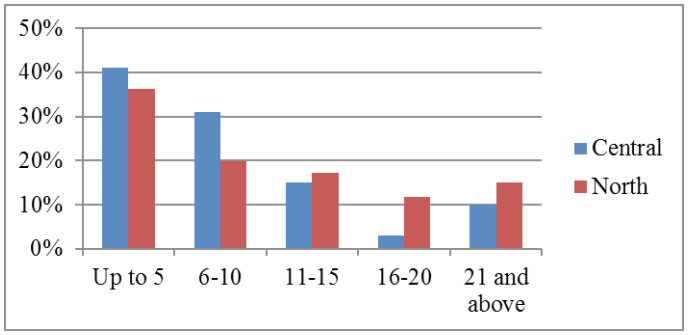

Figure 2: Number of years practicing fish farming by region, 246 Uganda fish farming households, 2016.

Field visits to fish farming households revealed varying status of fish farm enterprises as reflected in (Table 3). While majority of the fish enterprises in the sample households were functional, 10 percent had been abandoned. According to this study, functional ponds had fish stock and feeding of fish was regularly taking place. On the other hand, abandoned ponds were those found in un-functional status with no fish farming related activity taking place since 1999. The status of fish ponds may not just reflect commitment of the fish farmer, but also the quality of services provided by the extension staff as lack of capital and technical advice were the main reasons cited. For example, close to 60 percent of households with un-functional ponds did not receive any visits by district extension staff. In general, lack of regular extension visits often lead to farmer disillusionment and in extreme cases abandonment of the enterprise. Some of the farmers were, however, optimistic to rehabilitate their fishponds and resume farming once they got funds or free inputs particularly fingerlings and feeds from government.

Condition of fish farm enterprise	Frequency (Number of farmers)	Percentage
Functional/Operational	197	80.1
Not yet stocked	11	4.5
Under construction	11	4.5
Under renovation	2	0.2
Un-functional/Abandoned	25	10.2
Total	246	100

Table 3: Operational state of household fish pond, 246 Uganda fish farming households, 2016. Source: Survey data

The size of fishponds owned by farmers varied across the study area with the majority having total fish pond area of less than 1000m^2.

Extension Service Needs of Fish Farmers

Extension service needs of fish farmers are reflected in the various constraints they encountered in fish farming especially the first six given in Figure 3.

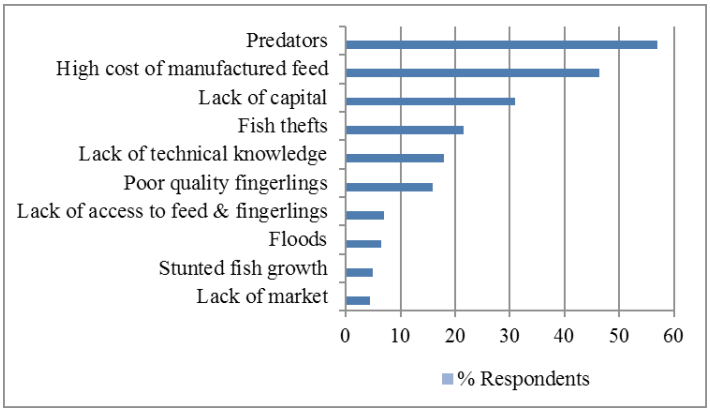

Figure 3: Constraints encountered by fish farmers, 246 Uganda fish farming households, 2016.

Four major constraints (predators, feeds, capital, and thefts) affected more than 20% of respondents in both regions. The constraints are common in fish farming across developing countries in Sub Saharan Africa. For example, studies carried out in Nigeria [36,37] report three similar key constraints (cost of feed, predators and thefts) faced by fish farmers. The scenario in Kenya is no different considering challenges hindering fish farming development [38]. These constraints reflect the pressing needs of fish farmers and constitute the demand side of aquaculture extension service provision.

Statistical tests for each of the six main constraints (Figure 3) revealed no significant difference ($p>0.05$) between the central and north implying that fish farmers in both regions encountered similar constraints. These results were expected since most variables explaining characteristics of farmers depict no differences across the two regions. Also, since fish farmers depend on extension workers and fellow farmers for almost all technical advice and information needed, they more or less run their fish farm enterprises in similar manner.

The presence of a fish pond in a particular place attracts predators that feed on fish. The common predators include otters, snakes, tortoises and birds and can lead to significant reduction of fish stock in ponds if control measures such as covering ponds with nets or fencing the fish pond area are not followed. Fish farmers cited lack of knowledge and high cost of fencing materials as reasons for inability to control predators. Measures to keep fish ponds free of predators is one of the typical intervention areas where extension staff can build on farmers' lived experiences in identifying and providing solutions to challenges faced by fish farmers.

While feeding fish is among key activities in fish farming, price of manufactured feed and access costs were reportedly unaffordable to most farmers. Less than 30 percent of respondents reported using factory manufactured feeds, despite known quality as per the nutrition information provided on the bags. Ugachic is the main fish feed company having started in 2004. Other fish feed manufacturing companies that started later include Ferdisult, Sabra and Kajjansi. Before, factory manufactured fish feeds became available, fish farmers fertilized ponds using manure to induce production of natural food and supplemented feeding with locally available materials such as maize bran, household meal left-over, vegetable leaves and fruits.

As a measure to cut costs of feeding fish, the majority of farmers (51.2%) use locally available materials, while 36.6 percent buy various feed ingredients and mix them on farm to produce feeds. Such alternative strategies for making feeds, however, compromise quality and result in poor fish growth. As fish farmers increasingly target the market, knowledge on feed management aspects such as type of feeds suitable for different fish species, feed rations in relation to quantity of fish stock, potential negative effects on pond water quality and monitoring fish growth is important. Periodic fish sampling and good record keeping is therefore essential for generating data that can be used by the farmers and extension workers in deciding appropriate fish feeding rations.

Lack of capital to finance fish farming is another constraint often raised by fish farmers. Whereas almost all (95.5%) respondents reported using their own savings to start fish farming, most of the money was spent on constructing fish ponds. This challenge was compounded by inadequate guidance by extension personnel during the process of planning for inputs needed particularly fingerlings and feeds. Other fish farmers started in anticipation of free fingerlings and feeds from the government, which often never came their way due to reasons not made known to farmers.

Free fingerlings and start up feeds were sometimes supplied to selected fish farmers under NAADS. Often, the supplies were not based on thorough assessment of farmers' needs and biased towards a few individuals labelled as contact farmers, leaving the rest anticipating delivery of free inputs. Such government interventions were often not clearly explained and lacked views of farmers as one District Fisheries Officer explained:

Using available limited budget, I conduct training for fish farmers in my district at least once a year. On other occasions I carry out farm visits though I often fail to reach everyone. Interacting with the farmers gives me opportunity to inform them about government programs but many times, NAADS programs have not been well synchronized with work-plans and budget releases to technical staff so you have no explanations to give to farmers on certain issues such as criteria for giving inputs (KII, Bukomansimbi district).

Fish farmers suggested support through provision of key inputs and training to farmer groups implying that extension services need to emphasize the provision of technical knowledge, information and social support as a whole package. The interventions should be, as suggested by Long (2001) [20], a result of a socially constructed and negotiated process that involves all actors.

Types of Extension Services Provided to Fish Farmers

A wide range of extension services, including techniques of proper pond construction, maintaining good fish pond environment and appropriate fish feeding are provided to fish farmers (Figure 4). Whereas these services are critical in improving production and productivity of fish farming, their widespread dissemination and adoption can best be achieved through social networks of farmers. This implies that support to formation and strengthening of farmers' groups is in itself a service that should be provided to fish farmers. Results clearly showed that services provided were largely in the form of technical knowledge and information aspects. Very few fish farmers received services to build social capital, yet activities such as information sharing or effective marketing of fish are best achieved through collective effort. This points to the need to treat farmers as active participants in extension service provision.

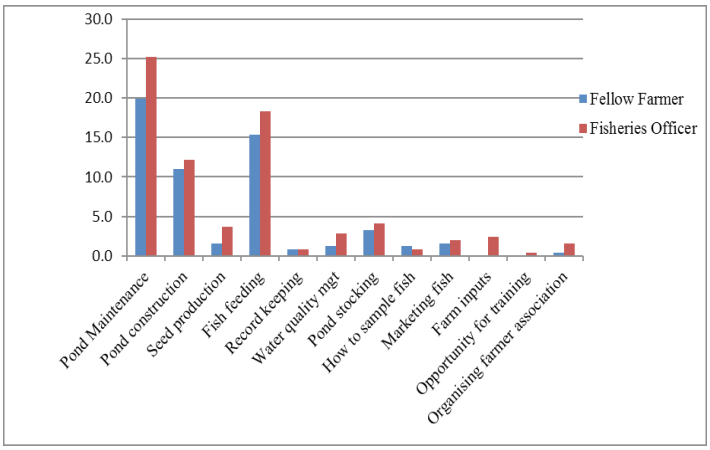

Figure 4: Extension services provided by major actors, 246 Uganda fish farming households, 2016.

Comparing the services provided and constraints mentioned by respondents shows a fairly close match to the critical extension needs expressed by fish farmers, except for capital which is beyond the mandate of the extension workers. Fish farmers can however be linked to small grants provided by government, although such grants tend to infuse a dependency syndrome especially if terms and conditions are not well explained to farmers. Since government policy on agriculture is to transform subsistence farming to sustainable commercial agriculture [30], farmers need training on managing their fish farming enterprises along business principles in order to access and utilize loans effectively.

Providers of Extension Services to Fish Farmers

The responsibility of providing extension services to fish farmers lies primarily with designated fisheries officers based at the district and sub-county headquarters. Among other duties, a District Fisheries Officer (DFO) provides overall supervision of the other fisheries officers deployed in the district to perform duties related to capture fisheries and aquaculture. Among other fisheries officers based at the districts, at least one is designated to handle aquaculture, although some districts had only one fisheries staff. A fisheries officer is responsible for various duties such as promoting adoption of improved fish farming and developing farmer institutions. These duties involve working closely with fish farmers to ensure effective execution of major fish farming activities. However, results of this study showed that only 48 percent of the fish farmers received extension visits from District Fisheries Officers in a period of twelve months, an indication of low extension-farmer coverage.

Farmers play a key role in providing extension services to one another through visits where they share information regarding fish farming. The study showed that 38.8 percent of fish farmers received visits from their fellow farmers. Some of the visits were initiated by the farmers themselves and not necessarily sanctioned by district fisheries officers. The fisheries officers confirmed that they often encourage fish farmers to visit and learn from one another. Although farmer-to-farmer extension visits are common, extension staff need to provide guidance in terms of authenticity and quality of advice given. Lessons from Kenya show success of farmer to farmer extension following integration into extension work by government workers. In addition, [39] found that although volunteer farmer trainers incurred some costs while training their fellow farmers, the social, human and financial benefits gained were comparatively greater. Examples of benefits gained included altruism, increased income, knowledge and skills. Volunteer farmer trainers were also found effective, though only simple technologies were disseminated due to lack of technical backstopping from extension workers [40]. Farmer-to-farmer extension can therefore be most effective if supported and guided by government extension workers since farmers may have limited technical knowledge in certain agronomic aspects.

Researchers and officers from MAAIF were among the least service providers mentioned by respondents. Providing extension services is not the official mandate of researchers, but inevitably takes place during research and dissemination activities carried out on selected fish farms. These research related activities form a complementary role to extension and are viewed as extension work since they provide responses and solutions to farmers' concerns. Other visitors mentioned by respondents included private extension service providers and staff from non-governmental organizations. Though officially recognized as providers of extension services, involvement in aquaculture is very limited.

Extension service provider	All (%)	Central (%)	North (%)	P value
District/Sub-county Fisheries Officer	40.0	41.0	65.3	0.046*
Fellow farmer	38.8	27.6	48.6	0.000*
None (No extension visitor received)	26.8	32.0	23.2	0.086
*Significant difference at 95% level of confidence.				

Table 4: Chi-square analysis of frequency of extension visits to fish farmers by major actors, 246 Uganda fish farming households, 2016.

Results displayed in the (Table 4) show that fisheries officers are the main actors providing extension services to fish farmers, followed by farmers. Further analysis of extension service delivery in terms of frequency of visits by fisheries officers in the central and north revealed a moderate statistically significant difference ($p<0.05$). There were more fellow-farmer extension visits in the north than in the central. Some of the District Fisheries Officers revealed that due to limited resources to carry out periodic farm visits, they identified contact farmers who volunteer to visit other farmers within their sub-counties and receive feedback from the contact farmer via phone. One of the DFOs explained:

I work with farmers who I identify as hardworking and having good interpersonal relations with their fellow fish farmers during training meetings that I organize at least once a year. I make telephone calls to them at least once a quarter to receive some kind of report about the farmers they manage to visit. When I receive some funds from the district, I plan my visits according to the reports I have received. For example, I may organize a general training or I may choose to visit a few farmers that require on-farm technical advice such as pond construction or assessing readiness of the pond for stocking with fingerlings. I had to devise this approach because of limited funding and lack of field-based staff (KII, Kole district).

The above revelation reflects level of commitment by extension staff to the extent of devising mechanisms that enable them to provide services to fish framers using the lowest cost possible. Results indicated that fisheries officer visits to fish farmers made once or twice a year are insufficient to address needs of farmers. Respondents rated extension services provided as useful, but irregular. The farmers preferred well planned regular visits and training sessions by government extension workers as the most efficient way to meet their fish farming needs. In addition, they proposed formation and strengthening of fish farmer associations through which to channel their demands for extension services.

Conclusion and Recommendations

Though introduced more than 50 years ago, aquaculture in Uganda remains a nascent venture poised to increase availability of fish only if farmers receive relevant extension services. Extension services for fish farmers have been inadequate despite the various reforms in the agricultural sector over the years. The NAADS program has been implemented since 2001 and by 2016 still had no tangible positive effect on improving aquaculture production at the household and national level. A thorough understanding of the demographic and socio-economic characteristics of fish farmers, including the nature and scale of operation should be considered in the planning and delivery of extension services. District based fisheries extension staff are primary agents of extension service provision and therefore need adequate budgets, transport and refresher training courses to carry out their duties effectively. Besides providing technical advice and information, they need to assist farmers to form associations through which relevant services can be provided more effectively. The associations would also be a means of fostering social relations among fish farmers and improve the current ad hoc and unplanned farmer-to-farmer extension.

Extension policy interventions need to be socially negotiated and adapted in view of the uniqueness of aquaculture as a new venture compared to crops and livestock farming. Improving aquaculture extension service provision requires a thorough understanding of different actors including their aspirations and limitations. Government commitment to improving the fisheries sector and aquaculture in particular should reflect increased staffing at district and sub-county levels. The "single spine" extension system has a clear chain of command and reporting, and is therefore likely to improve extension service provision as long as budgets allow effective implementation, monitoring, supervision and reporting.

Disclosure of Conflict of Interest

The authors have not declared any conflict of interest

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