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A SURVEY OF SMALL-SCALE RURAL AQUACULTURE IN MOZAMBIQUE

Isac Abel Chirindza
National Institute of Aquaculture Development
Rua Consiglieri Pedroso 347, 20 Andar
C.P 1723, Maputo, Mozambique
ichirindza@inaqua.gov.mz

Supervisor:

Prof. Helgi Thorarensen
Holar University College
helgi@holar.is

ABSTRACT

The National Institute of Aquaculture Development conducted a survey of small-scale rural aquaculture in Mozambique in 2007. The objective of this project was to analyse information collected through a questionnaire presented to fish farms as a part of the survey. The small hold fish farms are primarily small-scale extensive or semi-intensive producers of tilapia for consumption on the farms. In most of the farms, aquaculture is a secondary activity with other agriculture. The average production of a farm is 42 kg/year and the average yield is 1 mt/ha/year. The annual production in small hold fish farms in Mozambique was estimated as 179 mt in 2007 and multiplying the number of ponds with the average production of 25 kg/pond/year derived this number. However, the results of the survey suggest that this number is too high and that the average production is 9.3 kg/pond/year giving actual production of 67 mt/year. The questionnaire is a very useful tool to assess the status of small hold aquaculture in Mozambique. However, the questionnaire should be revised and improved.

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1 INTRODUCTION

1.1. Background

Mozambique lies on the eastern coast of southern Africa, between of 10º 27' and 26º 52' south latitude. It borders with the Republic of Tanzania to the north, Malawi, Zambia, Zimbabwe, South Africa and Swaziland to the west, and South Africa to the south. The east coast of Mozambique is on the Indian Ocean with coastal line about 2.780 km. The country has an area of about 799.380 square kilometres. Administratively, the country is divided into 11 provinces and 128 districts, administrative posts and localities. There are 33 municipalities, comprising the major urban centres, including 10 provincial capitals and the country's capital, Maputo, which also has provincial status (Figure 1).

Figure 1: Geographical location of Mozambique.

In 2007 the population was estimated at 20.632.434 million where 51, 9% are women. The annual population growth rate is 2, 8 percent. Eighty percent of the population lives in rural areas (INE 2010) where agriculture and livestock are of central importance to livelihoods.
The climate varies in the different regions of the country, but generally the inland areas are slightly cooler, although more humid than along the coast in the rainy season. Winter is the dry season lasting from April to September. The southern parts of the country are generally drier

and less tropical than the north, with temperatures along the coast averaging 27°C. The rainy season coincides with the heat and humidity from October to March, with average coastal temperatures of 31°C. Mozambique has some 60 major rivers, lakes and lagoons, unpolluted environment and availability of suitable local species for aquaculture.

Mozambique's agro-climate is strongly differentiated by three zones (MICOA 2007):
"1. The northern zone of the Zambezi River is humid, with a distinct rainy season.
Generally, water is available for crops for a full growing season, with drought conditions occurring only twice every ten years.
2. The central region, between the south of the Zambezi River and the north of the
Save River, experiences drought conditions approximately four years in every ten.
3. The southern region has a high risk of drought conditions, with drought conditions seven out of every ten years."

2 LITERATURE REVIEW

Aquaculture is a relatively recent activity in Mozambique. Fish culture in Mozambique started in the 1950s with the construction of embankment ponds for fish culture for farms workers in the provinces of Zambézia, Nampula and Manica. The colonial government built three research and demonstration centres in the early 1960s (IFPRI 2007). These were in Umbeluzi (0, 5 ha), Sussundenga (20 ha) and Chokwé (1, 6 ha). The main goal was to restock dams, lakes and natural reservoirs. These facilities were abandoned during the civil war and are currently degraded (Mapfumo *et al.* 2009, FAO 2010a).

According to FAO more than 258 000 hectares of land are available for small-scale freshwater aquaculture in Mozambique (MIPE 2007). However, it is estimated that presently only around 2,000 ha are used for fish farming. Recent studies (2009) showed the availability of 77.592,90 ha for earth ponds, 32.124,30 ha for cages and 10.590,73 ha for seaweeds that could be suitable for development of marine aquaculture (INAQUA 2010).

Currently, there are mainly two types of aquaculture in Mozambique: The culture of marine prawns in semi-intensive systems (MIPE 2007) with annual production of 1000 tonnes. Secondly, there is freshwater aquaculture in Mozambique, which has been growing since the early 1990s. Around 5500 people are involved in subsistence aquaculture in ponds as a part-time activity, of whom 3 500 are in tilapia extensive farming and 2000 in seaweed farming (FAO 2010a).

Many ponds in certain provinces such as Manica were set-up through funded projects such as the ALCOM programme (FAO 2010a). The small-scale fish production is currently estimated about 158 tonnes of freshwater fish a year (Table 1). This production comes from 8.035 ponds (100-400 m^2) in different parts of the country. Small-scale fish culture is most common in the provinces of Manica, Niassa and Zambezia (Figure 2), where around 2000 families are involved.

Tilapia *(Oreochromis mossambicus, Tilapia rendalli)* and common carp *(Cyprinus carpio)* are most commonly farmed and a limited production of catfish *(Clarias gariepinus)*. Other cultivated species include nile tilapia *(Oreochromis niloticus),* grass carp *(Ctenopharyngodon idella),* silver carp (*Hypophthalmichthys molitrix)* and bighead carp *(Aristichtys nobilis).* The

freshwater prawn *(Machrobrachium rosenbergii)* is also grown in Mozambique (MIPE 2007, Mapfumo 2009, Mapfumo *et al.* 2009 and FAO 2010a).

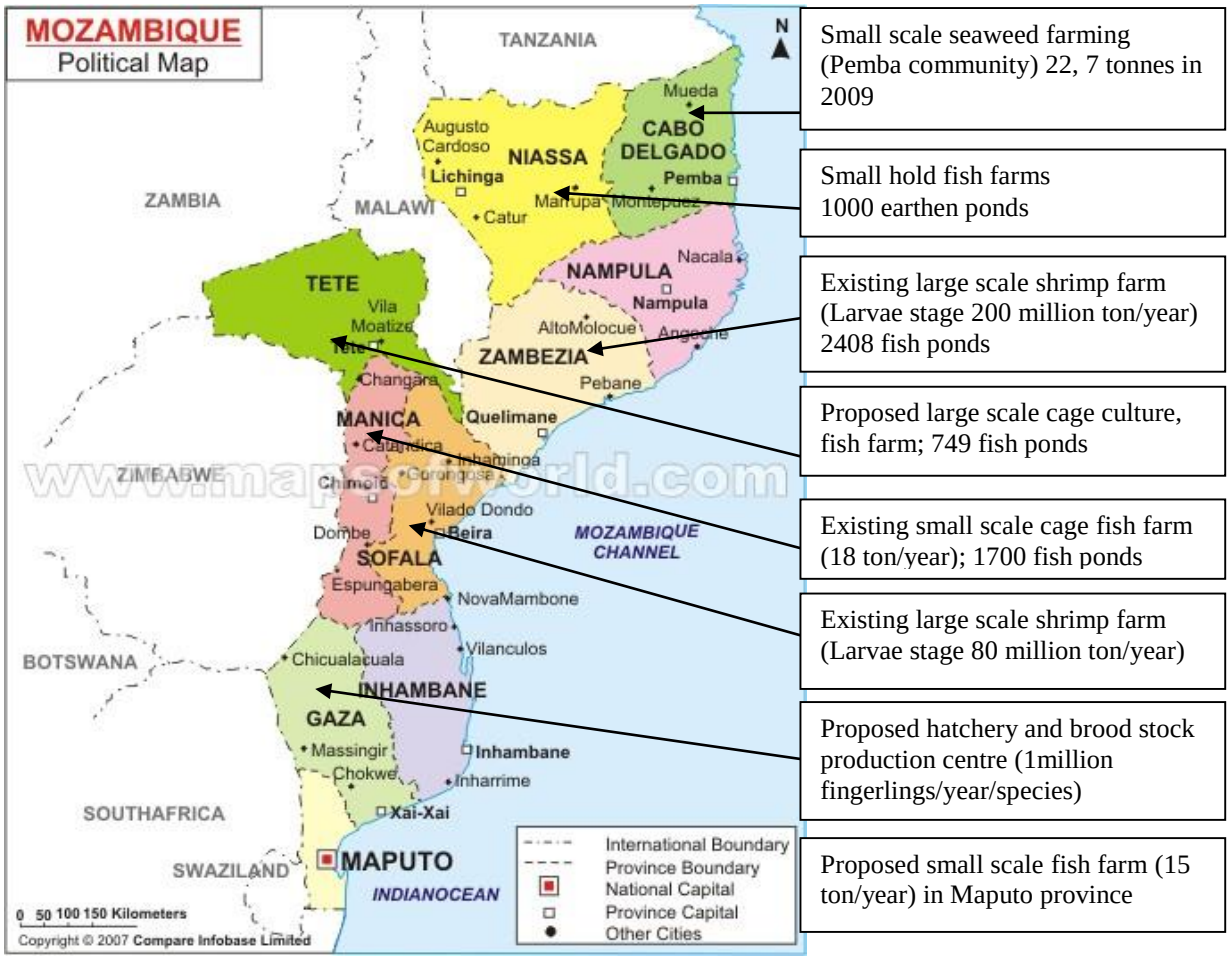

Figure 2: Aquaculture in different provinces. The figure shows the aquaculture projects and number of small hold fish farms in Mozambique (INAQUA 2010).

Table 1: Estimated aquaculture production, number of ponds and the number of beneficiaries in small-scale freshwater aquaculture in Mozambique in 2009 (INAQUA 2010).

Province	**Number of ponds**	**Number of beneficiaries**	**Estimate production (Kg)**
Maputo	89	252	204
Gaza	97		2.328
Inhambane	72	288	491,66
Manica	1.700	1.236	23.700
Sofala	896	232	6.650
Tete	749	620	18.725*
Zambezia	2.408		60.200*
Nampula	837	311	20.925*
Cabo Delgado	187	206	266,5
Niassa	1.000	4.705	25.000*
Total	**8.035**	**7.850**	**158.490,16**

*The production was estimated from the number of aquaculture ponds and assuming that the average production was 25 kg/pond/year.

The aquaculture production was estimated in half of provinces of Mozambique, assuming that the average production was 25 kg/pond /year. This may be unrealistic as conditions for cultivation vary.

Freshwater culture consists of integrated fish farming systems aimed at improving food safety and availability to the general population, while marine aquaculture is broadly oriented towards low-cost protein production and high-value products for export (Menezes 2001).

However aquaculture production in Mozambique decline for 2005-2008 (Figure 3). This decrease was due to climatic factors, disease and mismanagement, which led to the closing of one commercial farm.

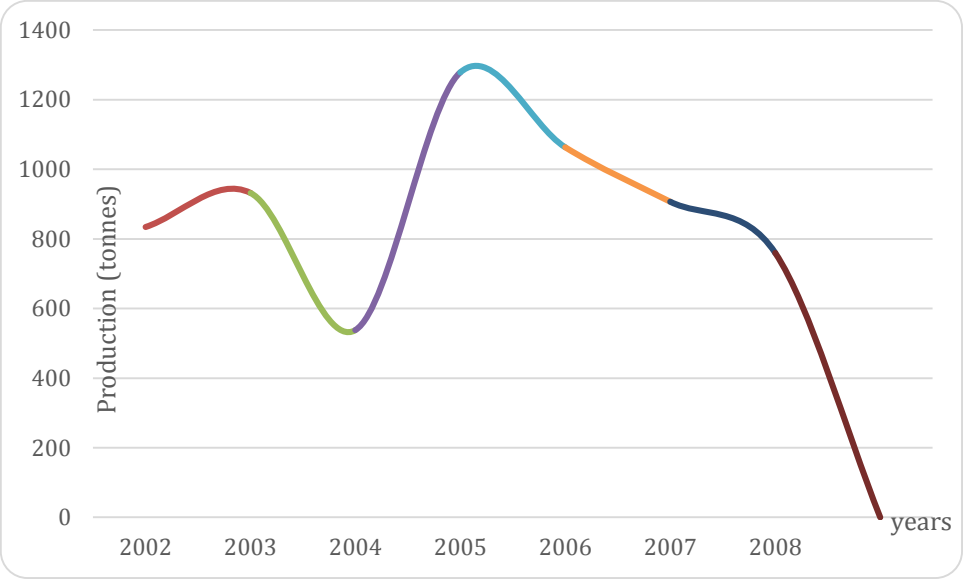

Figure 3: Evolution of the total aquaculture production in Mozambique (FAO 2010).

2.1 Production Systems

Aquaculture production is often classified in terms of intensity and scale of production into extensive, semi-intensive or intensive:

In extensive aquaculture the inputs are low and the fish primarily feed on food algae and zooplankton that grows in the water body. Stocking rates are typically low, there is little or no supplemental feed offered to the fish but low levels of fertilization in the form of manure may be applied to the ponds. The yield in extensive pond aquaculture is less than 1 mt/ha/year (Pillay 1993, Suresh 2003).

In semi-intensive aquaculture the ponds are fertilized by manure and inorganic fertilisers are applied. Normally the cycle production around 6-9 months and the yield varies from 1 to 5 mt/ha/year (Suresh 2003).

In intensive aquaculture input levels are high. The fish feed primarily on complete feed, stocking rate is high, water exchange is high and measures are taken to aerate or oxygenate the water to support the high levels of production (Boyd and Tucker 1998, Carballo *et al.* 2008). The annual yield in intensive aquaculture is higher than 5 mt/ha/year (Suresh 2003).

In small hold extensive aquaculture, household members usually manage the ponds. These farms generally do not require capital for running and there is no technical input into the production. The small-scale systems tend to be rural, and most of the fish is consumed by the family or sold on the pond bank (Machena and Moehl 2001, Carballo *et al.* 2008).

Medium- to large-scale systems have a water surface area of five hectares or more or produce more than 5 mt annually. Medium- and large-scale systems rely on urban markets and may rely on brokers or middlemen. These systems tend to be capital intensive, relying on bought labour, external energy sources and mechanization (Machena and Moehl 2001).

In Africa, about 95% of total aquaculture production is provided by small-scale extensive aquaculture in rural areas. The ponds are usually small (100-500 m^2) ponds and fish farming is integrated with other agricultural activities. The mean yield in small hold fish farms is about 0.5 mt/ha/year, although reported yields vary considerably, from less than 0.1 mt to more than 10 mt/ha/year (Machena and Moehl 2001).

Small hold farms in Mozambique are primarily extensive or semi-intensive. They use seed fish either form the wild or from hatcheries. There is limited or no use of commercial feed or equipment for mechanical aeration. Some supplemental feed may be offered but complete feed is generally not used.

Water used in the fish farms generally flows into the ponds by gravity from springs, seeps through the subsoil or comes from rivers. There is a general lack of good quality fingerlings, and mostly they are obtained from the wild or from neighbouring farmers. The tilapia breed in the ponds to produce fingerlings for subsequent production cycles.

2.2 Technical assistance

Extension services are weak in Mozambique as in most other African countries. The lack of infrastructure to support aquaculture activities and lack of funds make it difficult to provide extension services in the whole country. However, collaboration with District Services for Economic Activities (SDAE) has proven useful.

Alternative extension approaches that rely more on joint learning and evolutionary adoption have been tested and these might solve some of the problems currently faced in making productive technology available to fish farmers (Brummett *et al.* 2008). Through these process, in 2008-2009, more than 1080 extension workers and fish farmers received capacity building in Mozambique (INAQUA 2010).

It has been suggested, (Brummett *et al.* 2008) that Africa has the potential to produce 300 times the amount of fish currently produced globally. If even a small percentage of this were realized, fish would be readily available to all African consumers. However, at present, African aquaculture is still essentially a rural, secondary and part-time activity, taking place in small farms with small freshwater ponds (Coche *et al.* 1994, Aguilar- Manjarrez and Nath 1998).

In developing countries, such as Mozambique, where the majority of the population lives in rural areas and many households depend both on agriculture and livestock, which in turn depends mostly on the family's labour, it is important to increase productivity and income. Aquaculture can contribute to the increase of farm productivity and secure higher earnings for both -family and hired labour (Banze 2005).

Of the 3.6 million farm households in Mozambique, 24% are headed by women; and women are the principal producers of food crops for household consumption. Most household production is handled by women who, compared with men, have less access to improved agricultural technologies and credit (USG 2010).

The Gender Strategy for the Agrarian Sector founded in Mozambique in 2005 aims at assuring access to and control over resources, benefits, rights and equal opportunities between women and men. It is intended to enhance the capacity of vulnerable farmers, to improve food security and family income in order to contribute to poverty alleviation and a sustainable development incorporating a gender perspective (Ribeiro and Chaúque 2010).

A development plan will be implemented in Mozambique, to improve productivity and production in small-scale aquaculture, in the family sector. This identified constraints and potentials for the growth of these fish farms to become effective small family businesses. A part of the Small Scale Aquaculture Development Plan for Mozambican (Mapfumo *et al.* 2009) was a SWOT analysis of the strengths, weakness, opportunities and threats of developing the Mozambican small-scale aquaculture. This SWOT analysis was performed by INFOSA (Intergovernmental Organization for Marketing Information and Technical Advisory Services for the fisheries Industry in Southern Africa) on aquaculture in Mozambique in 2009. The main results are presented in Table 2.

Table 2: SWOT analysis of the development of the small-scale aquaculture in Mozambique (Mapfumo *et al*. 2009).

Strengths	• Availability of land and good quality water for aquaculture • Stable political and business environment • Species diversity • Unpolluted environment • Government priority • Willingness of small scale farmers to produce crops for fish feed
Weaknesses	• Lack of infrastructures and logistics • Weak capacity (trained personnel) and coordination between institutions • Few incentives for development in aquaculture • Heavy tax regimes and lending rates • Substantial post harvest losses and poor quality assurance • Little value added products/ product development/innovations • Over reliance on EU markets • Poor knowledge of market requirements/trends • Expensive fish feed and lack of local inputs Minimal local distribution network and Language barriers
Opportunities	• Build necessary infrastructures • Build capacity and train stakeholders • Review tax regimes / incentives and lending rates • Encourage investors and FDI • Encourage fish feed production/ feed formulation • Encourage applied research and development • Huge demand for fish and quality products • Introduction of new species • Encourage commercial farms to help in implementing projects with small scale farmers by government providing project start-up funding, and funding for field work.
Threats	• Lack of finance • Negligible FDI and donors assistance • High fuel cost • Lack of innovation capacity and re investment to improve productivity and efficiency • Natural catastrophes (cyclones, floods, etc) • Bad management of fish diseases • Bureaucracy

The main results of the SWOT analysis are that Mozambique has access to land and good quality water for aquaculture, a stable business environment and aquaculture is a Government priority. The main constraints to aquaculture development are poor infrastructures, lack of good quality fingerlings; fish feed, weak technical assistance and difficulty to access credit. However, the INAQUA is planning to set up an aquaculture demonstration and training centre in Chokwe, in Gaza province. If this development goes ahead it will improve brood stocks used by small-scale farmers, improve yields and support production practices. The centre is expected to increase technological transfer to farmers and extension technicians at provincial and district levels. The main opportunities are review tax regimes, introduction of new species and encourage commercial farms to help in implementing projects with small scale farmers by government providing projects start-up funding and funding for field work and the main threats are high fuel cost and natural catastrophes like cyclones, floods and drought.

Rationale

In July to December 2007 the Ministry of Fisheries, Aquaculture Department, conducted a survey in Mozambique of small scale fish farms into assess the stage of development of aquaculture in the country. The objective of the survey was to obtain basic information on the extent and nature of small hold aquaculture.

In June 2008, the government of Mozambique established the National Institute for Aquaculture Development (INAQUA) as part of its strategy to develop aquaculture in Mozambique approved on the 21st August 2008. INAQUA is responsible for forming aquaculture development policies, technical legislation and development plans; extension and management. It is also responsible for collecting statistics on aquaculture, analysis and processing data in small-scale rural aquaculture in Mozambique.

It is important to conduct a thorough survey of small hold aquaculture in Mozambique to assess the level of development of small-scale fish culture in each province or district. This is important to determine the type of technical and financial support needed by fish farmers. The survey in 2007 was the first of a series of identical surveys that are intended to assess the growth and development of aquaculture in Mozambique and its impact on communities. Mozambique does not have in place an effective system to collect statistics on aquaculture production. Yet this is very important for monitoring and evaluating the development of small hold fish farms and the impact of government programmes on aquaculture production. The questionnaire is intended to be an important tool in collecting information on aquaculture in Mozambique.

3 OBJECTIVE OF THE STUDY

In this study, the data of the first survey were analyzed and revised the questionnaire for collecting information.

3.1 General objective

The general objective of the project is to summarise baseline data on small-scale aquaculture in Mozambique and revise the questionnaire for collecting information. The main objective of this project is to analyse information collected through a questionnaire presented to fish farmers in 2007 as a part of the survey.

3.2 Specifics objectives

The specific objectives of this study were:

1. To collect information about small hold fish farms in Mozambique including:
    a. Background information on fish farmers.
    b. Ownership and running form of farms.
    c. The number of people who depend on the fish farm for sustenance.
    d. The number of women involved.
    e. Information on farms and farmers
        i. What other sources of income the farmers have
        ii. Method of farming
        iii. Species produced
        iv. Source of water

   v. Size and number of ponds
   vi. Age of the farm
2. Information on farm management:
   a. Feeding of fish and fertilization of ponds.
   b. Methods of harvesting
   c. Labour
3. Information on environmental impact of farming and the conservation status of the species farmed.
4. Quantity of harvest and destination of harvested fish.
5. Level of assistance and advice sought by the farmers.
6. The main problems faced by the farmers.

4 METHODOLOGY

Several teams of technicians from the National Institute of Aquaculture Development, the provincial fisheries offices, and extension officers of the District Services for Economic Activities (SDAE) conducted the survey.

Three technicians carried out the survey over a period of 15 days in each province. There is a paucity of information on small-scale fish farms in Mozambique and no central registration of fish farms. Therefore, the technicians consulted local fish farmers about the location of other fish farmers. To cover the entire province, it was necessary to use a 4x4 vehicle and work in collaboration with the fish farmers. However, it was not always possible to use the car because of poor road condition. The teams were instructed to work in partnership with provincial directories of fisheries to continue the survey.

In this project, data from the survey in 2007 was analysed using the Microsoft Excel program. The data was entered into a spreadsheet and analysed using PIVOT tables for descriptive statistics (average, frequency and variation). SPSS was used to analyse correlations of some variables affecting production (Pearson correlation).

5 RESULTS

5.1 Location of fish farms in the survey

The survey in 2007 was conducted in eight provinces of Mozambique (Table 3) . Most of the fish farms were in the provinces of Manica, Nampula, Zambezia and Niassa provinces (Table 4). These are also the provinces where most fish farms are located. The total number of fish farms included 285 or 18% of the estimated total number of ponds in Mozambique (Table 3).

Table 3: Number of ponds in different provinces. The table shows the total number of ponds and ponds surveyed in 2007.

Province	**Total number of ponds ***	**Number of ponds surveyed**	**Proportion %**
Cabo Delgado	61	6	10
Manica	1828	244	13
Maputo	97	45	46
Nampula	836	233	28
Niassa	766	199	26
Sofala	391	39	10
Tete	664	325	49
Zambezia	2371	198	8
Gaza	92	-	-
Inhambane	64	-	-
Total	**7170**	**1289**	**18**

***Source: MIPE 2008**

5.2 Ownership and organisation of fish farms

The small hold fish farms are organized in associations or individually. In this survey association is a group or co-operative of fish farmers who have joined together to develop aquaculture activities in individual or common ponds in the same area.

Of the farms included in the survey, 73 (26%) were members of associations and family owned farms were 212 (74%). In the provinces of Manica (93%), Nampula (81%) and Zambézia (73%) the majority of farms were family owned. However, in the provinces of Cabo Delgado (100%), Tete (58%) and Niassa (56%) most of the farms were associations (Table 4).

Table 4: The number of associations and family farms sampled in the survey.

Province	Association %	Family %	Total number of farms
Cabo Delgado	100,0	0,0	4
Manica	7,0	93,0	104
Maputo	31,0	69,0	13
Nampula	19,0	81,0	58
Niassa	56,0	44,0	34
Sofala	33,0	67,0	9
Tete	58,0	42,0	26
Zambezia	27,0	73,0	37
Grand Total	**26,0**	**74,0**	**285**

The survey showed that the women were involved in 71% of the farm associations.

5.3 Fish farmers and people depending on the production for sustenance

The fish farmers produce for people dependent and beneficiaries. Dependent is a person that is supported by the fish farmer, usually family members. Beneficiaries can either be direct or indirect.

The direct beneficiaries include dependents (family members) and indirect beneficiaries include buyers who buy fish from the ponds, neighbours or even extended relations. Beneficiaries can also be students at a school that uses fish from the fish farms. This is the largest group of beneficiaries in this study.

For the farms surveyed in the questionnaire, the total number of people who relied on the fish farms for food was 3384 family members (dependents) and 3874 other beneficiaries that were not part of the families (Table 5). However, the distinctions between the two groups in the survey is not very clear and the same people appear to be counted both as dependents and beneficiaries since the questionnaire lists the same number of dependents and beneficiaries in 73% of the farms. The total number of beneficiaries in farms where there are no dependents (27%) is 2211. This suggests that the total number of people that depend on fish from the farms for food is 5595 or 19, 6 people per farm on average.

Table 5: The number of dependents and beneficiaries sampled in the survey.

Province	Dependents	Beneficiaries
Cabo Delgado	52	
Manica	982	889
Maputo	361	88
Nampula	564	1578
Niassa	642	175
Sofala	54	61
Tete	457	603
Zambezia	272	480
Total	**3384**	**3874**

5.4 Labour

In total, 57% of the farms relied on family as labour while other farms depended on other members of the association (20%), hired staff (20%) or found other labour (3%), mainly students. Farms where both family and hired personnel worked on the farm were 9% of the total. The mean distance from fish farm to the residence of the fish farmer ranged from 1m to 35km but the average distance was 900 m.

5.5 Other sources of income than fish farming

Nearly all the farmers had other sources of income than aquaculture (Figure 4), mainly in agriculture (97%) and livestock (75%). Less than 10% had income from handicraft, coal production and carpentry. About 15% had other sources of income than listed above and most of those were in business.

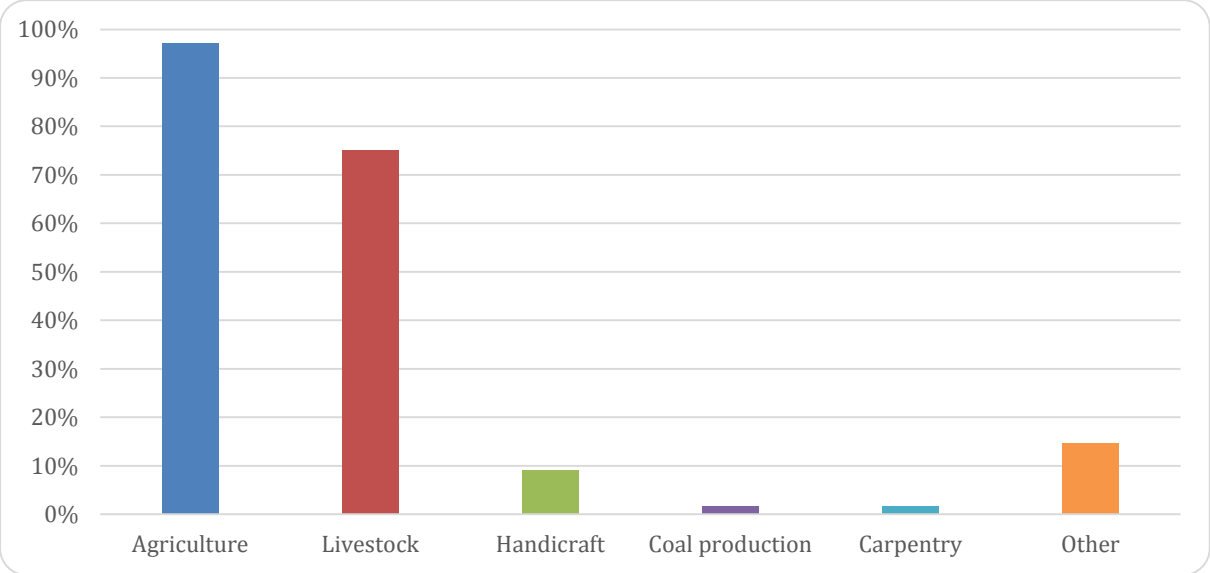

Figure 4: Others source of income of fish farmers.

5.6 Pond size and structure

Most of the fish farms (98%) used earthen ponds to grow the fish and only 2% of the farms used cement ponds, embankments or lagoons. The size of the ponds ranged from 8-1600 m^2 (Figure 10) with a mean size of 134 m^2. The most common size range of ponds was 76-100 m^2 and 61% of the ponds were 150 m^2 or less (Figure 5).Also, the average number of ponds in each fish farm was 4,5 ponds/farm.

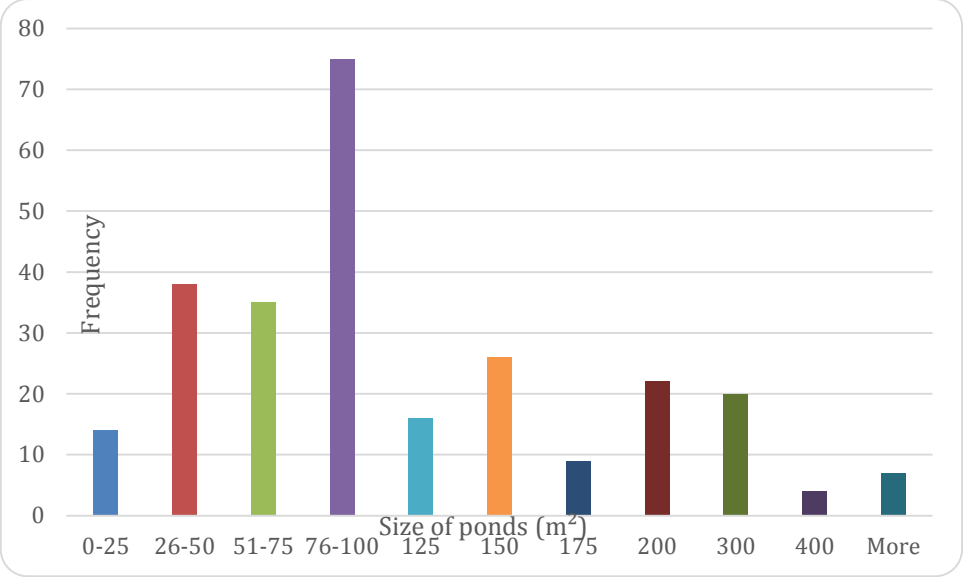

Figure 5: Size of ponds in small hold fish farms.

Three farms used brackish water while the rest of the farms used freshwater. Most commonly the water flowed into the fish ponds from the subsoil by gravity (46%). Some of the farms received water from springs (30%) and rivers (22%) via purpose built canals.
In total, 77% of the ponds were in use and 23% not in use.

5.7 Maintenance status of farmed species used in small hold fish farms

Most of the farmers (95%) considered the conservation status (Figure 6) of the species farmed to be good or at least acceptable while only 5% thought that it was poor. However, it is not clear what is meant by good conservation status.

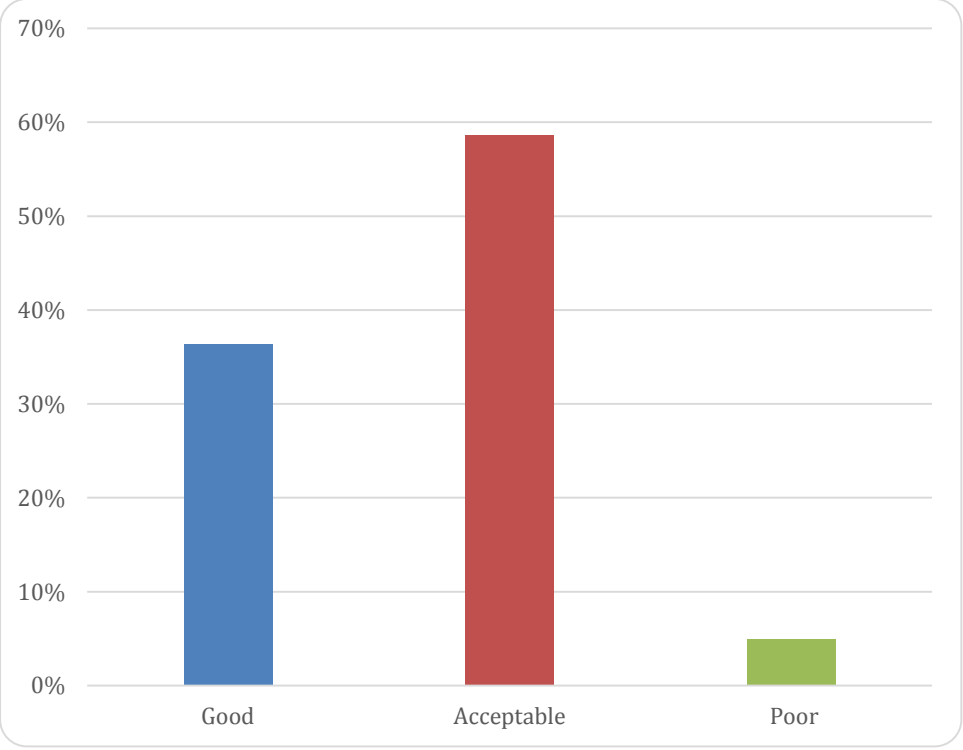

Figure 6: Conservation status of fish farms.

5.8 Species farmed

The most common aquaculture species (Table 6) was tilapia, which was farmed in 94% of the fish farms. Common carp was farmed in 5% of the fish farms and other species (catfish and not identified) were grown in 1% of the farms. The weight at harvest of fish was 100-500 g (average weight 300 g).

Table 6: Most common aquaculture species.

Species	Scientific name
Tilapia	*Oreochromis mossambicus*
Tilapia	*Tilapia rendalli*
Tilapia	*Oreochromis niloticus*
Common Carp	*Cyprinus carpio*
Catfish	*Clarias gariepinus*
Other	0, 67% not identified

5.9 Feeding and fertilization

The most common supplementary feed presented was corn bran (Figure 7) vegetables and food scraps. Less than 1% of the farms used prepared feed. Other feed sources were primarily cassava leaves and termites. Only 1% of the farms did not feed the fish or apply fertilizer to the ponds. In total, 19% of the ponds were fertilized with manure. The questionnaire did not ask about the quantity of feed or manure used.

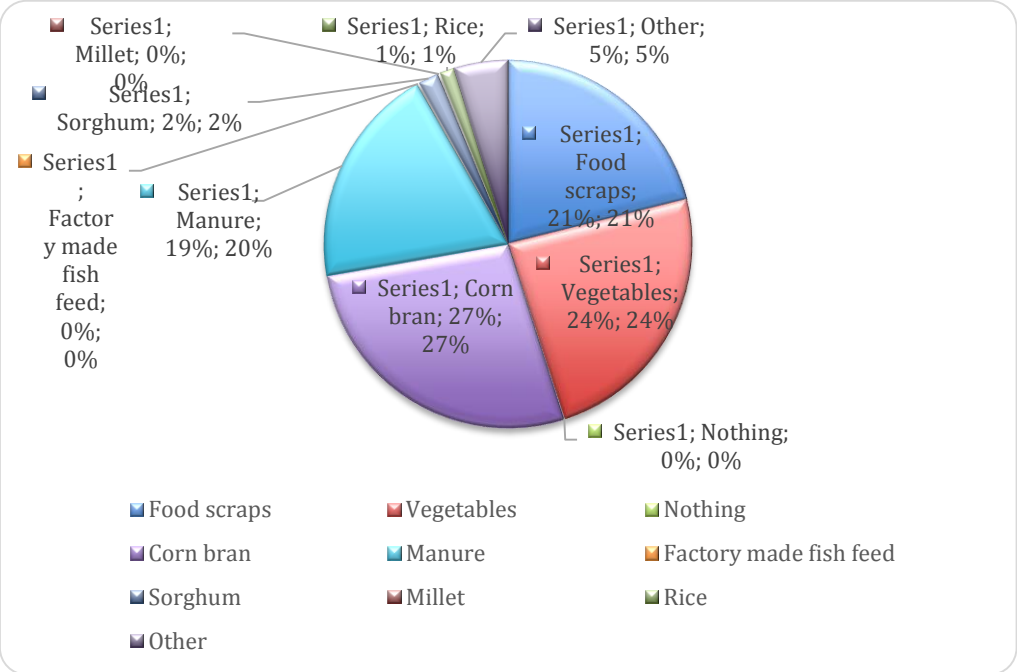

Figure 7: Source of feed used by the farms.

5.10 The age of the fish farms

The oldest fish farm visited was founded in 1976 while, 75% of the farms had been operated for five years or less (Figure 8). However, the number of new small hold fish farms increased from 2002-2005 but decreased in 2006 and 2007.

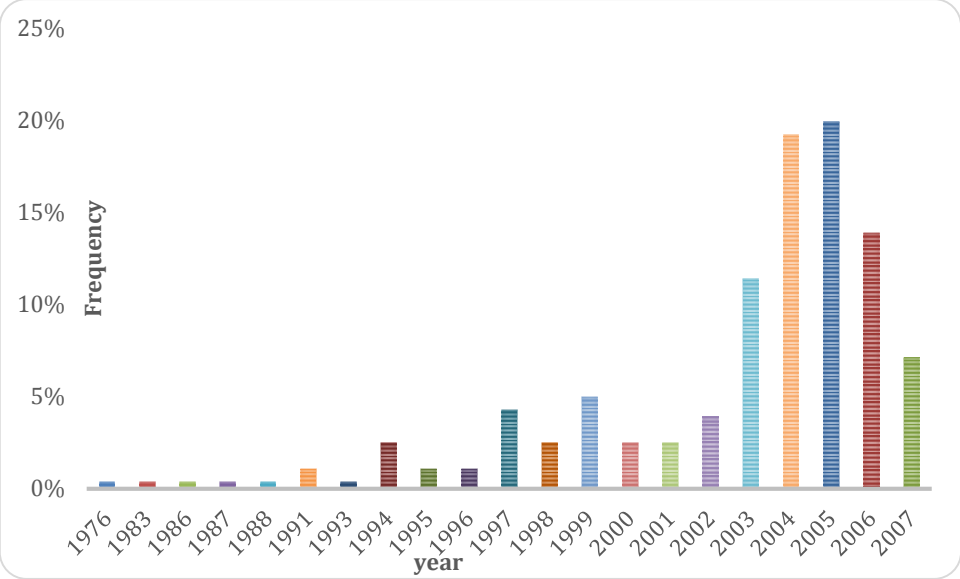

Figure 8: The year when the fish farms started operation.

5.11 Aquaculture production

When all the data was included the average yield in the fish farms was 6571 kg/ha. This is a high value for extensive aquaculture where the expected yield is up to 1500 kg/ha. In semi-intensive aquaculture the expected yield is 1 500-15 000 kg/ha year. The information provided on the farms in the on Therefore, the data set was revised to include only fish farms where complete data was supplied on pond number, pond size and production while excluding all farms with a yield over 15 000 kg/ha. When the farms with incomplete data and the outliers were excluded the data set included 192 farms.

In the revised data set the average of yield was 1mt/year. There was no reported production in 37 fish farms. These were farms either did not produce any fish or were less than one year old and had not produced any harvest yet (Figure 11).

Most of fish farms produced less than 200 kg/year and average farm production was 42 kg/year (Figure 9). About 160 (56%) of the fish farms produced less than 21kg or nothing at all and few farms produced more than 1000 kg/year (Figure 9)

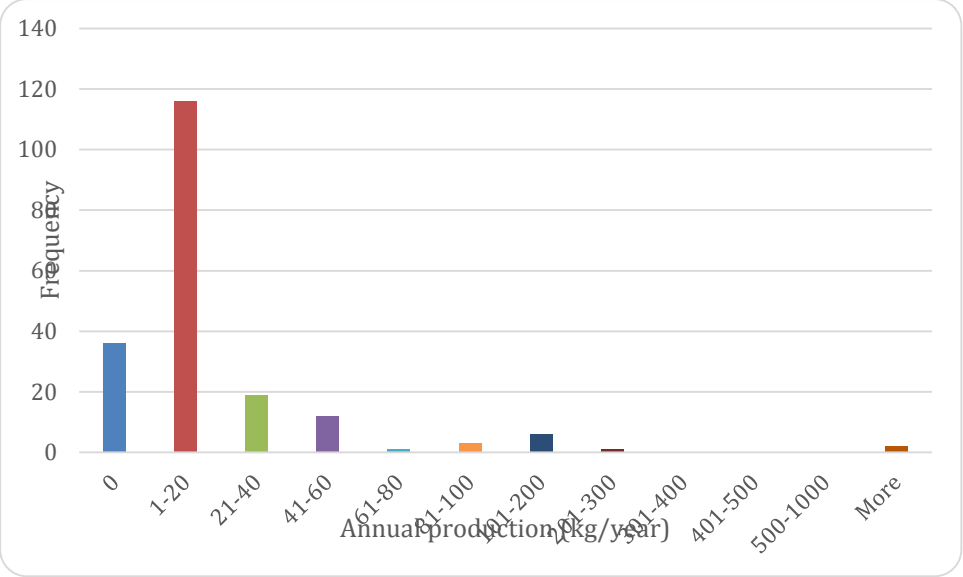

Figure 9: Annual production of farms surveyed in 2007.

The annual production in most of fish ponds was less than 20 kg/year (average 9,3Kg/pond) and 75 fish ponds produced less than 1kg or nothing (Figure 10).

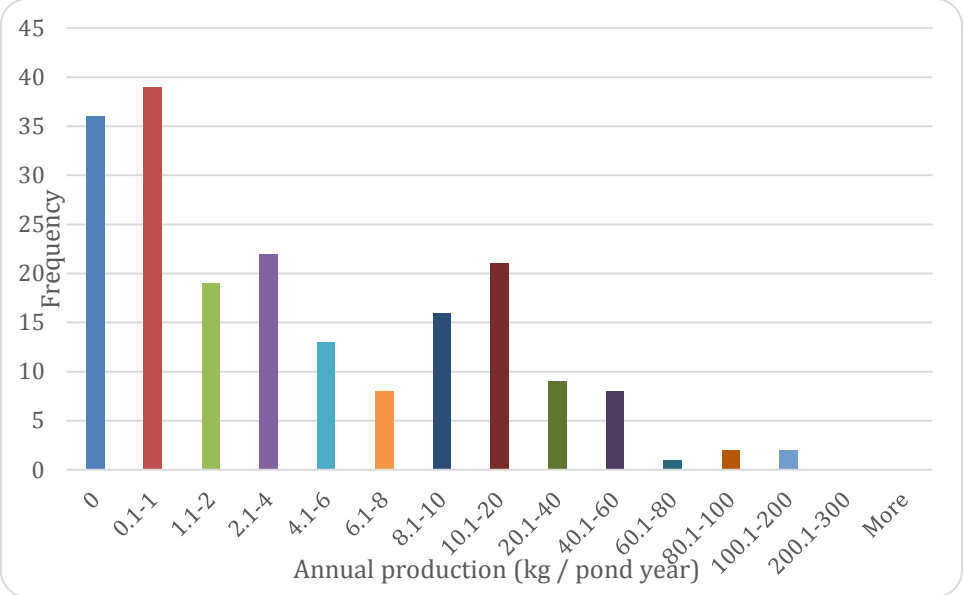

Figure 10: Annual production in ponds.

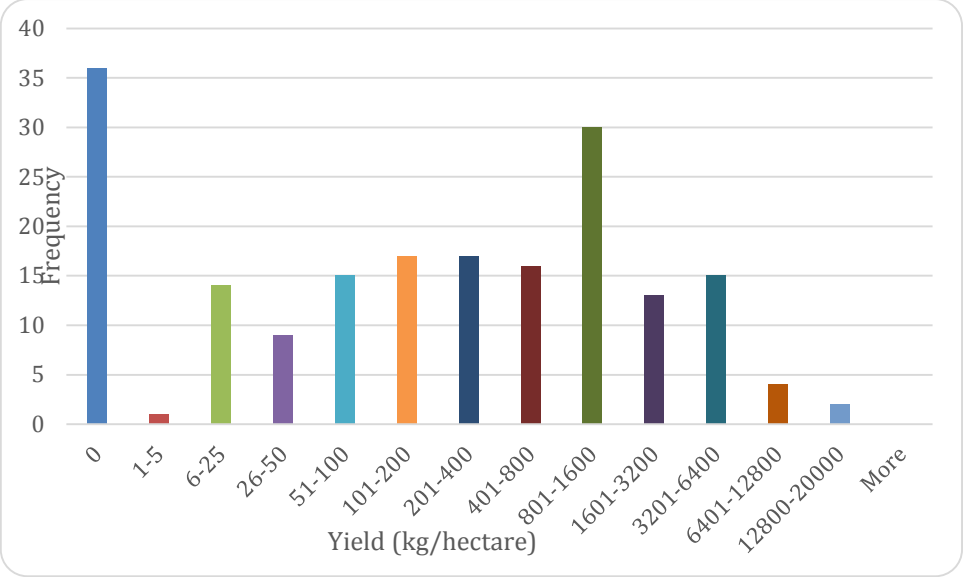

Figure 11: Annual yield in different small hold fish farms.

5.12 Correlations of some variables affecting production

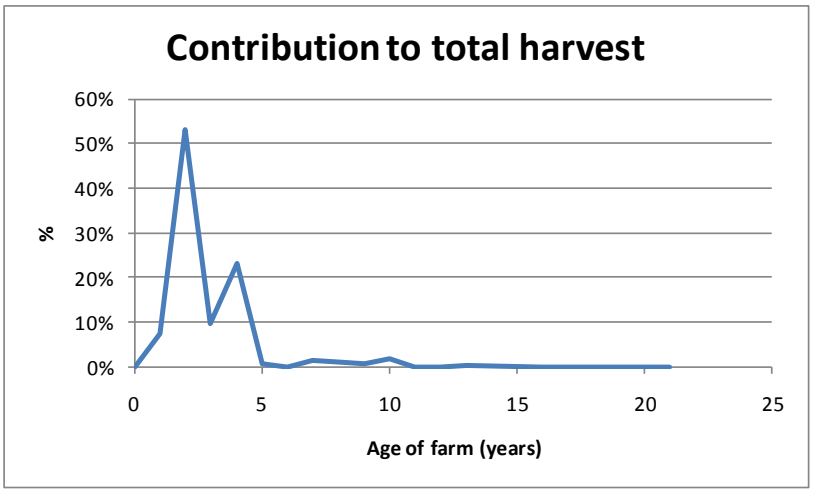

Figure 12: The total productions of small hold farms of different age. The figure shows the combined average production of farms in different age.

Farms that are less than five years old are responsible for about 95% of the freshwater aquaculture production in Mozambique (Figure 12). The reason for this is that farms that are less than five years old both have higher average annual production than older farms (Figure 13) and they are more numerous (Figure 8).

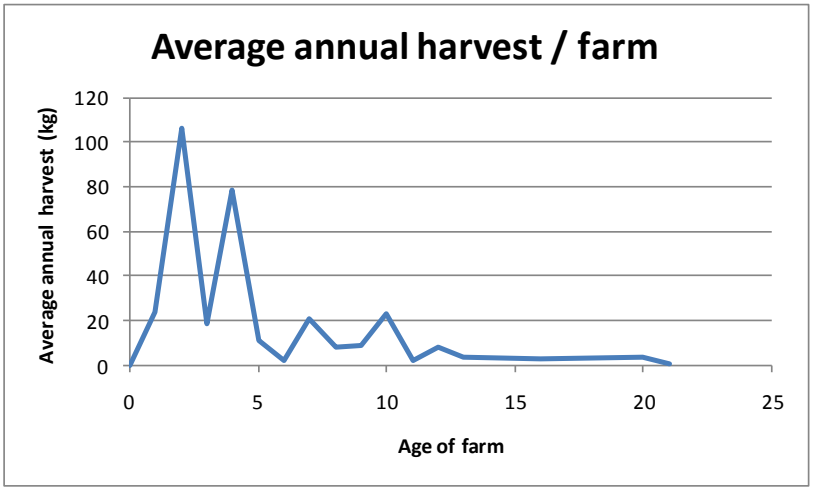

Figure 13: Average annual harvest of farms of different age.

To examine what contributes to the higher annual production in younger farms several factors were correlated with annual production.

Table 7: Multiple correlations of factors that can affect the annual production. The table shows both the Pearson correlation coefficient and the significance level of the correlation.

			Annual harvest	Harvest / pond	Yield	Average pond size	Average pond number	Total area of ponds in farm
Age of farm	Pearson Correlation		-0.44689	-0.46634	-0.51647	-0.11319	-0.27775	-0.26785
	Sig. (2-tailed)		0.072113	0.059175	0.033787	0.665335	0.280417	0.298611
Annual harvest / farm	Pearson Correlation			0.642425	0.689667	0.297298	0.403	0.376889
	Sig. (2-tailed)			0.00542	0.002189	0.246512	0.108729	0.135902
Harvest / pond	Pearson Correlation				0.94847	0.11607	0.121142	0.121017
	Sig. (2-tailed)				6.92E-09	0.657317	0.643259	0.643603
Yield	Pearson Correlation					0.143849	0.258518	0.221751
	Sig. (2-tailed)					0.581766	0.316404	0.392339
Average pond size	Pearson Correlation						0.649357	0.769942
	Sig. (2-tailed)						0.004789	0.0003
Average number of ponds	Pearson Correlation							0.941333
	Sig. (2-tailed)							1.79E-08

The factors that mainly affected the annual production of the farms were primarily associated with yield. There was a significant negative correlation between the age of farms and yield. Moreover, annual production was positively correlated with yield (Figure 14) as was the correlation between harvest/pond and annual harvest. However, correlation between annual harvest and pond number or total area of ponds was not significant (Table 7).

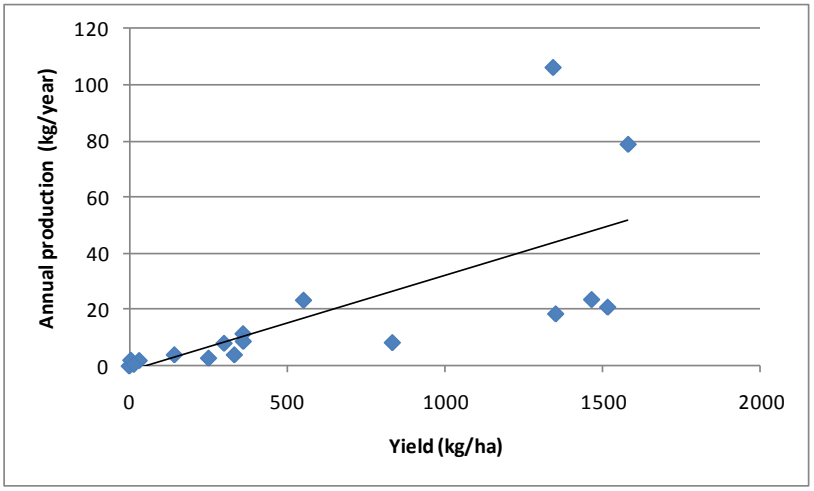

Figure 14: Annual production and yield of farms.

5.13 Destination of fish produced

Most of the fish farms produce for own household consumption (80%) as shown in (Figure 15). In total 23% of the farms sell fish commercially and, 3% of fish production sold for stocking.

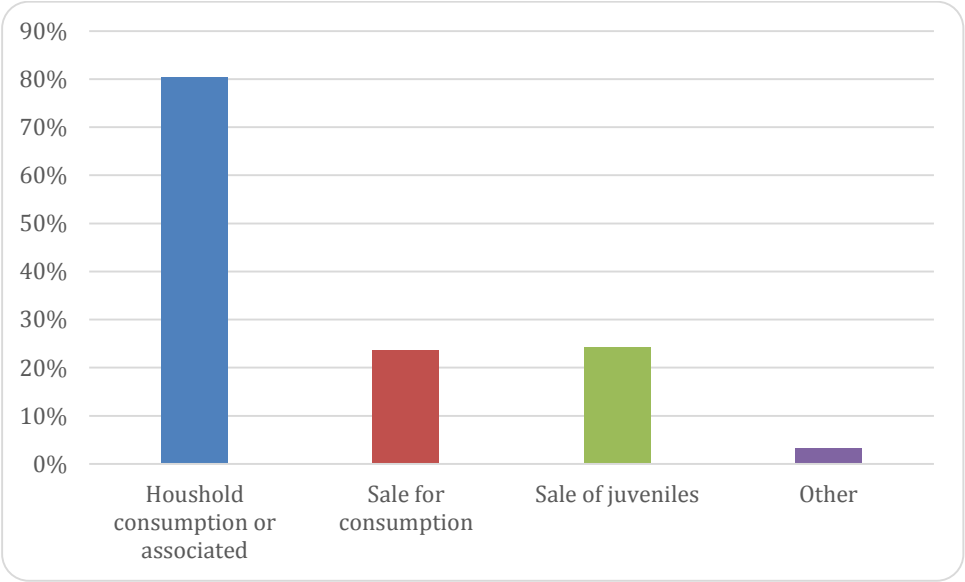

Figure 15: Destination of fish production from small hold fish farm.

Most of the farms used fishing nets, hooks and mosquito nets to harvest the fish (Figure 16). Thus, 71% farms did partial harvests, i.e. harvested only part of the fish in the ponds each time, while 15% of farms harvested all the fish from the pond. Farms where fish had never been harvested were 14%.

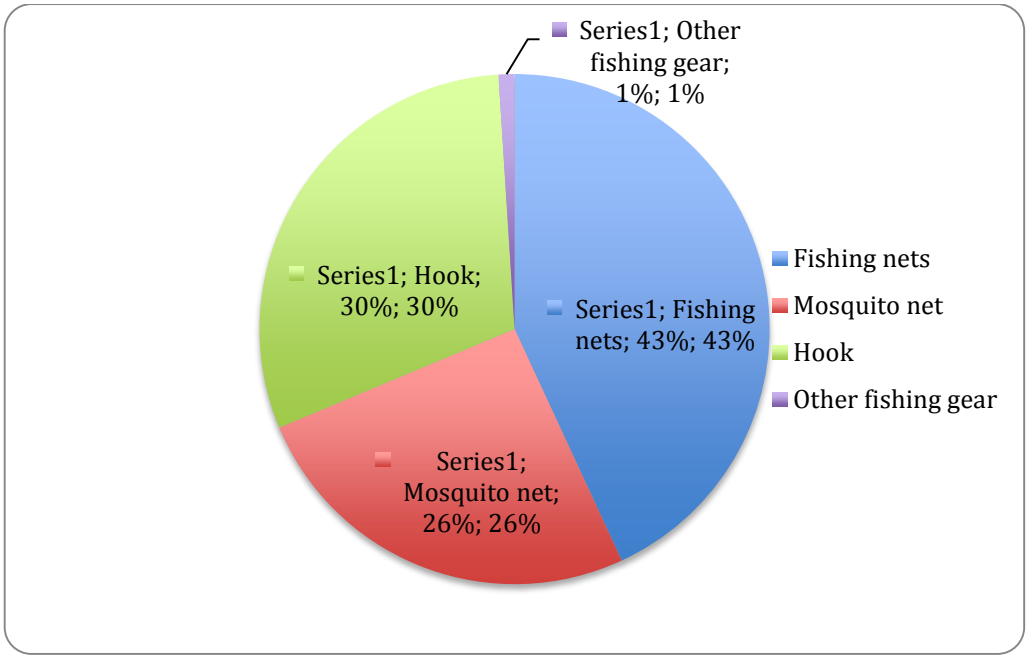

Figure 16: Fishing gear using in small hold fish farms.

5.14 Technical assistance

About 60% of the farms sought specialist assistance when starting the farm and also while running it. Moreover about 23% of the fish farmers sought advice either initially or while running the farms. However, 19% of the farms never sought advice. Most of the farms received technical assistance from District Services for Economic Activities (SDAE) (Figure 17), while fewer received technical assistance from INAQUA and NGO, neighbouring farmers and owner fish farmer.

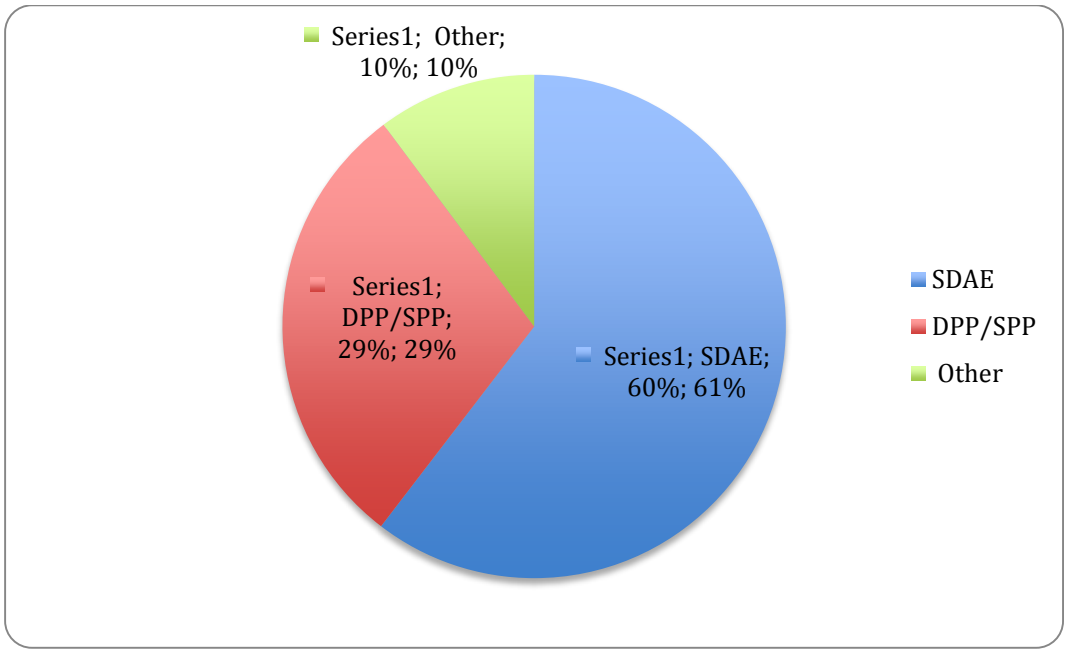

Figure 17: Provision of technical assistance.

Those seeking technical assistance did so most commonly four times each year (Figure 18) while 19% never sought advice.

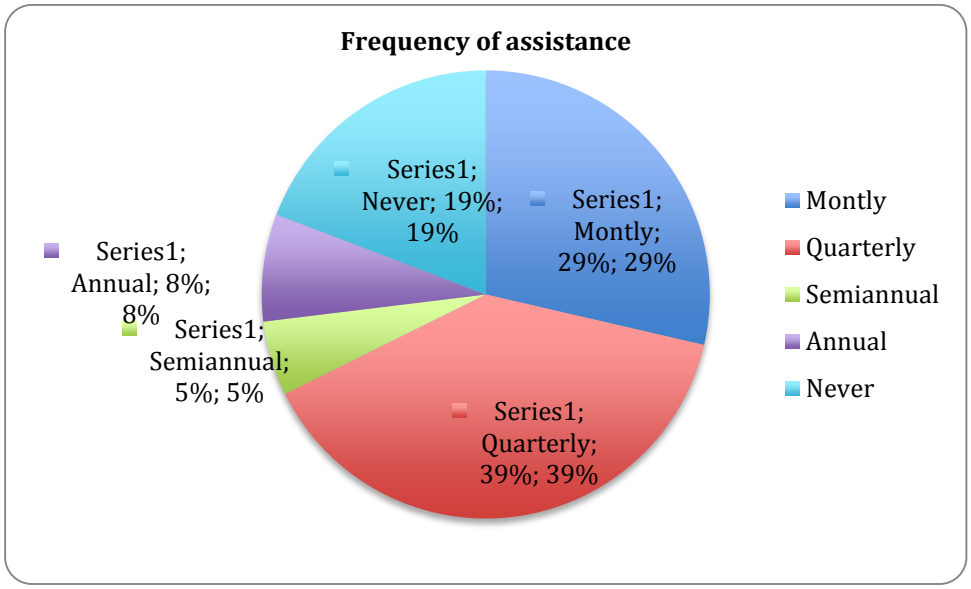

Figure 18: Frequency of technical assistance.

5.15 Problems faced by small hold farms

Most of the farmers (95%) indicated that they had faced problems (Figure 19). The most common problems encountered were predators and low technical assistance or lack of technical assistance. Other problems identified were lack of fingerlings, materials and tools for pond construction, water quality and fishing nets.

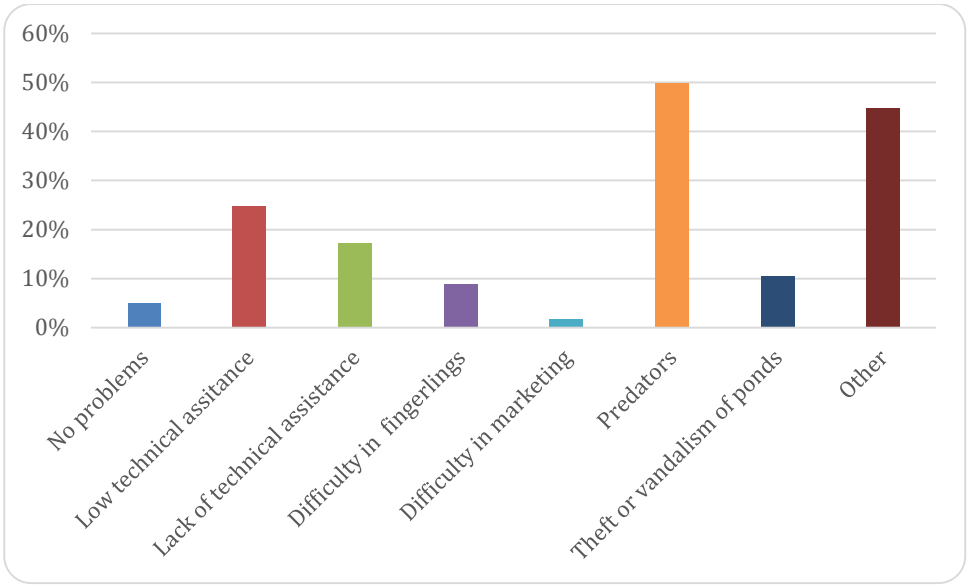

Figure 19: Source of problems in small hold fish farms.

6 DISCUSSION

This is the first study investigating the basic indicators on rural aquaculture in Mozambique. The questionnaire addressed a broad range of indicators including: (a) location of fish farms in the survey, (b) ownership and organisation of fish farms, (c) involvement of women in small hold farms associations, (d) fish farmers and people depending on the production for sustenance, (e) labour, (f) other sources of income than fish farming, (g) pond size and structure, (h) maintenance status of farmed species used in small hold fish farms (i) species farmed, (j) feeding and fertilization, (k) age of farm, (l) aquaculture production, (m) destination of fish produced, (n) technical assistance and, (o) problems faced by small hold fish farms.

6.1 Location of fish farms in the survey

Most farms were in Manica, Nampula, Zambezia and Niassa provinces (Table 3). According to (INAQUA 2010) Manica, Zambezia and Niassa have many fish farms, but Nampula province has less fish farm than Sofala province (Table 1). However, the survey covered 18% of small hold fish farms at the time (Table 3). This distribution of fish farms is not according to actual distribution

6.2 Ownership and Organisation of fish farms

Most of the fish farms were run as family enterprises rather than as part of fish farmer associations (Table 4).

The province of Cabo Delgado was special in that all farms were parts of associations. However, the fish farms in this province are few (Table 3) and it is a coastal province with ready access to fisheries.

6.3 Involvement of women in small hold farms associations

Women were involved in 71% of the farms that were parts of associations. These data indicate that women are increasingly engaged in activities that were once considered only for men. Jobs in aquaculture are widely perceived as being dangerous and uncomfortable for women. As a result women have a low representation in the sector (12% of aquaculture workforce), are usually in jobs of lower importance and often on a temporary basis (FAO 2006). According to (USG 2010), in Mozambique women, compared with men, handle most household production and they have less access to credit.

Postharvest activities are critical for employment and income generation, especially for women (FAO 2010b).

6.4 Fish farmers and people depending on the production for sustenance

The average number of people depending on the fish farms for food was 19.6/farm. The average size of rural families in Mozambique is 4.7 persons / household (INE 2004). This suggests that the small hold fish farms generate food or income for about five households. However, the average annual per capita consumption of fish in Mozambique is 7-10 kg/year. Therefore, aquaculture production of the small hold farms is not adequate to meet the needs of the producers.

6.5 Labour

Most of the farms rely on members of the family as labour. However, 20 % of the farms on relied on hired labour. In rural area 90% of population are economic only active. Moreover 53.8% of rural population are self-employed (INE 2004).

The fish farms are usually close to the residence of the owner (average distance 900 m). This is the reason that more half of small hold fish farms are family-run.

6.6 Other sources of income than fish farming

The low production volume and the fact that nearly all farms are also involved in other farming activities suggest that aquaculture is secondary and not the main source of food and income. According to (INE 2010) 80% of Mozambicans live in rural areas, where agriculture and livestock are of central importance to their livelihoods. The main basic food crops cultivated in rural areas are maize, sorghum, millet, rice, beans, sweet potatoes, groundnuts and cassava (INE 2010).

6.7 Pond size and structure

Nearly all farms used earthen ponds. The mean size was 134 m^2 and the range was from 8-1600m^2. About 23% of existing ponds were not in use. The survey did not address why ponds were not in use. It is possible that some of the abandoned ponds could be poorly constructed or located. It may be of interest to address this in further questionnaires.

6.8 Maintenance status of farmed species used in small hold fish farms

Most of the fish farms consider the conservation status of the species farmed as good (Figure 6), but in questionnaire is not clear what is meant conservation status.

6.9 Species farmed

Tilapia sp was the most commonly farmed species (Table 6) in 94% in all the small hold fish farms while carp and catfish were only found in Manica province. The unidentified species are probably wild fish. These results are in accord with reports from (MIPE 2007), (Mapfumo 2009) and (FAO 2010a) that the most common farmed fish species are tilapias *(Oreochromis mossambicus, Tilapia rendalli)*, and common carp *(Cyprinus carpio)*, with low production of catfish *(Clarias gariepinus)*.

The questionnaire does not specify if the ponds were only stocked once or repeatedly. However, 1 fish/m^2 is well below the recommended levels and INAQUA suggests the stocking rate of 2-5 fish/m^2.

After partial harvest the remaining fingerlings become the stock for the next production cycle. This practice may in due course result in low yields (Mapfumo 2009).

6.10 Feeding and fertilization

Most of fish farms feed the fish (Figure 7). However, the questionnaire did not inquire about the quantity of food used.

6.11 Age of farm

The number of small hold fish farms increased 2002-2005 but has decreased in the last two years. This suggests that decreased interest or decreased incentives for aquaculture among farmers in recent years. In many country, small hold fish farms is a marginal activity, poorly integrated into rest of their farming, badly managed, a tendency to be abandoned and less than optimal productivity.

6.12 Aquaculture production

The average annual production (Figure 9) was 42 kg/farm/year. However about 56% of small hold fish farms produced less than 21 kg/pond and some produced more than 1tonne/pond/year. The average annual production was 9, 3 kg/pond (Figure 10) and annual yield (Figure 11) was 1 mt/ha/year. The average weight was 300 g, which is slightly higher than the average for sub-Saharan countries where the average harvest weight rarely exceeds 100 g (FAO 2006).

Estimations of the number of fish ponds in Mozambique in 2007 made by extension officers indicate that ponds in small hold fish farms are 7170. The total production in small hold farms is estimated based on this number and the estimate production per pond (25 kg/pond/year (INAQUA 2010). This gives an annual production of 179 mt/year in 2007. New estimate of total production based in 9, 3 kg/pond indicate that small hold fish farms produced 67 mt/year in 2007. Thus previous estimations of aquaculture production in small hold fish farms where too high.

A 2005 review on aquaculture development in Sub-Saharan Africa showed that in commercial fish farming systems, at various levels of intensification, productivity varies from 3-10 tonnes/ha/year and in non-commercial fish farming varies from 0,28 tonnes to 3 ton/ha/year.

Suresh (2003) showed that in extensive pond aquaculture is less than 1 mt/ha/year, semi-intensive aquaculture the ponds are fertilized by manure and inorganic fertilisers are applied the yield varies from 1 to 5 mt/ha/ha and in intensive aquaculture the yield is higher than 5 mt/ha/year (Suresh 2003).

If the annual yield in small hold fish was 1mt/ha/year most of the farms in Mozambique are extensive or semi-intensive producers' small scale.

6.13 Correlations of some variables affecting production

The (Table 7) showed that exist a significant negative correlation between the age of farms and yield and significant positive correlation between annual production also yield. The increased production in farms that are less than five years old is a result of increased number of farms and yield. Thus the younger farms (Figure 12 and 13) are better managed than farms over 5 years old.

6.14 Destination of fish produced

Most of the fish farms were harvested for household consumption (Figure 12). The harvests are normally carried out for household consumption (Machena and Moehl 2001), when the farmer finds a customer to buy the fish (Mapfumo 2009) or for the local barter economy (Brummett and Williams 2000).

6.15 Technical assistance

Extension workers in the districts provided technical assistance (Figure 14). The provincial fisheries offices are located in provincial capitals.

Most farms that received technical assistance did so four times each year. INAQUA has trained about 1080 people both extension workers and fish farmers to provide technical assistance to fish farmers in Mozambique.

6.16 Problems faced by small hold farms

In general, all the fish farmers had faced the problems. However, the existence of predators, weak technical assistance, materials and tools to pond construction, good quality fingerlings, fish feed is a reality. This was also observed in a study conducted by INFOSA in 2009.

The weak or lacking technical assistance in rural aquaculture is one of the constraints to development of this activity. However, the INAQUA is using efforts to establish pilot units' cultivation of fingerlings and demonstration centre and training in Chocke, Province Gaza (INAQUA 2010).

7 CONCLUSIONS

The small hold fish farms in Mozambique are primarily small-scale extensive or semi-intensive producers of tilapia and are still secondary and part-time activity. The total production of small hold farms is low and the production is mainly for household consumption.

The decrease in production in recent years suggests that the small hold fish farms is marginal activity, poorly integrated into the rest of their farming, badly managed, a tendency to abandoned and less than optimal productivity.

The questionnaire is a very useful tool to assess the status of small hold aquaculture in Mozambique. However, the questionnaire should be revised and improved.

8 RECOMMENDATIONS

The present questionnaire includes all small-scale aquaculture in Mozambique. However, the survey was done in a rural area. Thus, should separate small hold fish farms from other types of small-scale aquaculture. The followings suggestions were made:

a) Include number beneficiaries but not number of dependents;
b) GPS to indicate the geographical location of small hold fish farms;
c) The area of farm in square meters not average pond areas;
d) Separate feeding and fertilization and;
e) In Production, include the season of the year where farmer harvest fish, i.e. which months in a year when farmer harvests fish for household consumption and how much for each month.

The annexes show the old model questionnaire (annex 1) and suggestion of the new model questionnaire (annex 2).

ACKNOWLEDGMENTS

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ANNEX 1

REPUBLIC OF MOZAMBIQUE MINISTRY OF FISHERIES Institute of Aquaculture	**INVESTIGATION OF BASIC INDICATORS FOR SMALL SCALE AQUACULTURE** Date: / / The Inquirer_____	**YEAR____** **—** **_____** **PROVINCE**

Fill in with block letters
In squares, fill with Y (yes) or N (no)
In the questions unanswered or where the information is uncertain, complete with (-)

If family, the name of the owner of the ponds:	If associative, the name of the association:
	Name of president:
Number of dependents :	Number of members of the association:
Number of beneficiaries:	Number of women associated:
Other sources of income: ☐ Agriculture ☐ Livestock ☐ handicraft ☐ Coal production ☐ Carpentry Others_____ _____	
Observation:	

2. LOCATION

Location of ponds:	Residence of fish farmers **:**
District:	District:
Administrative post :	Administrative post:
Locality:	Locality:
Village:	Village:
Walking distance or time between home and the fish farm:	
Observation:	

3. DESCRIPTION OF FISH FARM

<table>
<tr><td colspan="4">Aquaculture in:
☐ Earth ponds ☐ Floating cages Others _____</td></tr>
<tr><td colspan="2">Farmed (s) specie (s):
☐ Tilapia ☐ Carp Others_____</td><td colspan="2">Water used:
☐ Fresh ☐ Salt ☐ Brackish</td></tr>
<tr><td>Number of ponds/cages:
Used_____
Not used_____</td><td>Dimension of the ponds/cages (m^2):</td><td>Year of start of activity:</td><td>Initial number of juveniles:</td></tr>
<tr><td colspan="4">Feeding:
☐ Food scraps ☐ Vegetables ☐ Nothing ☐ Corn bran ☐ Manure
☐ Ration ☐ Sorghum ☐ Millet ☐ Rice
Other:_____</td></tr>
<tr><td colspan="4">Harvest:
☐ Fishing net ☐ With mosquito net ☐ C With hook Other fishing gear_____</td></tr>
<tr><td colspan="4">Maintenance status of aquaculture species: ☐ Good ☐ Acceptable Poor ☐</td></tr>
<tr><td colspan="4">People involved in care of fish:
☐ Family members ☐ Persons hired ☐ Members of the association Others _____</td></tr>
<tr><td colspan="4">Observation:</td></tr>
</table>

4. PRODUCTION

Provision of fingerlings:	Number of harvest : Partial harvest_____ Total harvest_____	Quantity of harvest: Partial harvest_____ Total harvest_____	Approximate size or weight of fish:

Destination of fish produced:
☐ Household Consunption or associated ☐ Sale for consumption ☐ Sale of juveniles Other _____
Observation:

5. TECHNICAL ASSISTENCE

During opening of ponds/cages:	**In monitoring ponds/cages:**	**Source of assistance:**	**Frequency of assistence:**
☐ Yes ☐ No	☐ Yes ☐ No	☐ SDAE ☐ DPP/SPP Other: _____	☐ Monthly ☐ Quarterly ☐ Semiannua☐ Annual
Observations:			

6. ENVIRONMENTAL ASPECTS

Is water entering the ponds treated: ☐ Yes ☐ No	**Is water leaving the ponds treated:** ☐ Yes ☐ No	**Does the water leaving the ponds irrigate land:** ☐ Yes ☐ No
The water in the ponds comes from: ☐ Tap ☐ Well ☐ River ☐ Lake ☐ Source ☐ Subsoil ☐ Estuary ☐ Sea		**The cages are submerged in:** ☐ River ☐ ☐Lake ☐stuary Sea
Observation:		

7. PROBLEMS FACED

☐ No problems ☐ low a technical assist☐ce Lack of technical assistance ☐ ☐ Difficulty in the aquiring fingerlings Difficulty in marketi☐g Predators ☐ Robbers or assolts on ponds/cages Others: _____
Observations:

ANNEX 2

REPUBLIC OF MOZAMBIQUE **MINISTRY OF FISHERIES** **Institute Of Aquaculture**	**A SURVEY OF SMALL SCALE RURAL AQUACULTURE** Date: / / The Inquirer_____	**YEAR_____** **PROVINCE** _____ ___

Fill in with block letters
In squares, fill with **Y** (Yes) or **N** (No)
In the questions unanswered or where the information is uncertain, complete with (-)

If family, the name of the owner of the ponds:	If association, the name of the association:
	Name of president:
Number of beneficiaries:	Number of members of the association:
	Number of women associated:
Other sources of income: ☐ Agriculture ☐ Livestock ☐ Handicraft ☐ Coal production ☐ Carpentry	
Others_____ _____	

2. LOCATION

Geographical Location of ponds	Residence of fish farmers **:**
Latitude	District:
Latitude	Administrative post:
Longitude	Locality:
Longitude	Village:
Walking time between home and the fish farm:	
Observation:	

3. DESCRIPTION OF FISH FARM

<table>
<tr><td colspan="4">Aquaculture in:
☐ Earth ponds ☐ Floating cages Others _____</td></tr>
<tr><td colspan="2">Farmed (s) specie (s):
☐ Tilapia ☐ Carp
Others_____</td><td colspan="2">Water used:
☐ Fresh ☐ Brackish</td></tr>
<tr><td>Number of ponds/cages:
Used_____
Not used_____</td><td>Area of farm (m^2):</td><td>Year of start of activity:</td><td>Stocked number of juveniles:</td></tr>
<tr><td colspan="2">Feeding:
☐ Food scraps ☐ Vegetables ☐ Millet bran
☐ Fish feed ☐ Sorghum bran ☐ Rice bran
☐ Corn bran ☐ Nothing
Other:_____
_____</td><td>Fertilization
☐ Manure
Other_____
___</td><td>Provision of finger lingers/origins of fry:</td></tr>
<tr><td colspan="4">Harvest:
☐ Fishing net ☐ With mosquito net ☐ C With hook Other fishing gear_____</td></tr>
<tr><td colspan="4">Maintenance status of aquaculture species: Good ☐ Acceptable ☐ Poor ☐</td></tr>
<tr><td colspan="4">People involved in care of fish:
☐ Family members ☐ Persons hired ☐ Members of the association Others _____</td></tr>
</table>

4. PRODUCTION

Season of the year where farmer harvest a lot of fish:	Number of harvest : Partial harvest_____ _	Quantity of harvest : Partial harvest_____ Total harvest_____	weight of harvested fish:

	Total harvest_____ __		
Destination of fish produced: ☐ Household Consunption or associated ☐ Sale for consumption Other _____			
Observation:			

5. TECHCNICAL ASSISTENCE

During opening of ponds/cages:	**In monitoring ponds/cages:**	**Source of assistance:**	**Frequency of assistence:**
☐ Yes ☐ No	☐ Yes ☐ No	☐ SDAE ☐ INAQUA Other: _____	☐ Monthly ☐ Quarterly ☐ Semiannual ☐ Annual
Observations:			

6. ENVIRONMENTAL ASPECTS

Is water entering the ponds treated: ☐ Yes ☐ No	**Is water leaving the ponds treated:** ☐ Yes ☐ No	**Does the water leaving the ponds irrigate land:** ☐ Yes ☐ No
The water in the ponds comes from: ☐ Well ☐ River ☐ Lake ☐ Spring ☐ Subsoil		**The cages are submerged in:** ☐ River ☐ Lake
Observation:		

7. PROBLEMS FACED

☐ No problems ☐ Lack or low technical assistance ☐ materials and tools for pond construction

☐ Difficulty in the aquiring fingerlings ☐ Water quality ☐ Difficulty in marketing Predators ☐

☐ Robbers or assolts on ponds/cages Others: _____

Observations: