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Assessment of Factors Hindering Small Scale Fish Farming (SSFF) in Namibia

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Abstract – **The aim of this paper is to assess factors hindering Small Scale Fish Farming (SSFF) in Namibia, specifically in the central north part of Namibia. Out of total 76 small scale farmers, active farmers receiving fingerlings on a continuous basis from the Ministry of Fishery and Marine Resources Extension Office. Only about 37 farmers were randomly selected and interviewed. The data was analysed using Principal Component Analysis (PCA) and Meta-analysis.**

The Meta analysis shows that lack of training opportunity, transport, marketing; support service (that includes production, processing, storage, distribution, marketing, infrastructure and cold-chain storage) hampered the sector badly. In addition to this unreliable transportation, network also complicated the situation.

The PCA results categorised in three based on the variation of the structure of component matrix explanation. In the first component known as availability of technology, running cost of fish farm, training for aquaculture and fish feed availability, low level of financial assistance, anticipated yield and size of ponds influence negatively.

Therefore, it is crucial to strengthen technical and organisational (fish farmers associations, groups or cooperatives) capacity of fish farmers and producers' understanding of aquaculture socio-economic aspects (that may include business plan, record keeping, etc.).

Keywords – **Small Scale Fish Farming, Principal Component Analysis (PCA), Meta-Analysis, Namibia.**

I. Introduction

Worldwide, the number of people lacking access to minimum diet requirements has risen from 824 million to 1020 million between 1990 and 2009 [1]. In Africa the incidence of hunger and associated malnutrition is estimated to be more than 35% of the population which is much higher than the rest of the world [2]. Apparently malnutrition is severe in Sub-Saharan Africa (SSA) especially among children. To aggravate matters further HIV/AIDS that has complicated the socio-economic situation in the region, particularly among subsistence farmers who cannot acquire required vitamin-rich and balanced diet. The situation is further aggravated by global warming and variability of climate [1].

Namibia is not exceptional from the above mentioned challenges as about two-thirds of the population (1.5 million) living in communal lands and are dependent on rain-fed agriculture [6] & [7]. In addition to this, social and economic remains the biggest challenge in Namibia, for example high income inequality (with estimated Gini coefficient at 0.59), high unemployment (with 29% unemployment rate) and high poverty incidence (with estimated rate of 21% of individuals consumption below $1.25/day) [10].

As part of the initiatives to address the above challenges, within the context of national vision 2030 operating within five-year National Development Plans (NDP).The government of Namibia has acknowledged the potential and importance of aquaculture development in the country. As a result number of aquaculture research centres and small scale fish farms has been established close to most fresh water bodies such as rivers, lakes and reservoirs, dams, floodplains, wetlands, boreholes and canals. Government is promoting fish farming with the goal of enhancing food security, job creation and income generation particularly in rural areas. In 2001 about 568 small scale farmer were registered under the Ministry of Fisheries and Marine Resources (MFMR) extension database, in the central northern part of Namibia, however over the past five (5) years, only 76 farmers are continuously farming and receiving fingerlings (accounted only for 13%), which means about 87% small scale farming initiatives discontinued due to multitude reasons [5]; which this research focusing to identify.

Therefore, within the above background, the aim of this paper is to assess factors hindering Small Scale Fish Farming (SSFF) in central north part of Namibia.

II. Materials and Methods

A. Data source and sampling procedure

This study focused only to those 76 active SSFF; only 37 farmers were selected randomly for this study. The sample size was considered were sufficient due to (i) the population and the livelihood activities around the study area homogenous. And (ii) due to wider scattered geographical location of the SSFF time and cost is not allowing to cover all those 76 farmers.

B. Methodological framework

While Ordinary Least Square should have been possible model for the analysis, it was not used due to a large number of parameters (around 23) that was further complicated by a limited number of observations of 37 observations. It could not yield reliable linear relationship as parametric assumption would have been violated. For that reason instead of creating relationship among the parameters, it was decided to measure the impact of each and every variable's magnitude hindering small scale fish farming using the Principal Component Analysis (PCA). As indicated in [3] the model found to be the right estimator due to the following reasons:

i) To determine the influence of each every component and to reduce the variables that explain best hindrance factors on integrating fish farming on their system;

ii) The model also known as factor analysis as a statistical technique used to examine the interrelations among a set of variables to identify the underlying structure of those variables

iii) It is also non-parametric analysis and the results are unique and independent of any hypothesis about data distribution [4];

iv) PCA is a multivariate statistical method commonly used to reduce the number of predictive variables and solve the multi-colinearity problem (Bair et al. 2006 cited in [4]); this statistical tool looks for a few linear combinations of the variables that can be used to summarise the data without losing information in the process. This method of dimension reduction is also known as "parsimonious summarisation of the data" (Rosipal and Krämer, 1989 cited in [4]).

The PCA is computed by determining the eigenvectors and eigenvalues of the covariance matrix. The covariance matrix is used to measure how much the dimensions vary from the mean with respect to each other. The covariance of two random variables (dimensions) is their tendency to vary together as:

$$Cov\,(X,Y) = E[E[X]-X].E[Y]-Y] \ldots\ldots\ldots\ldots\ldots.(1)$$

Where E[X] and E[Y] denote the expected value of X and Y respectively; for a sampled dataset, this can be explicitly written out as follows:

$$Cov\,(X,Y) = \sum_{i=1}^{N} \frac{(X_i - \bar{X}\,(Yi - \bar{Y})}{N} \ldots\ldots\ldots\ldots\ldots.\ldots(2)$$

With $\vec{X}$ = mean (X) and $\vec{Y}$ = mean (Y) where N is the dimension of the data set. The covariance matrix is a matrix A with elements $A_{i,j} = cov(i,j)$. It centres the data by subtracting the mean of each sample vector (Jeong, et al, undated)

In principal component analysis, the following important points are very important to follow to estimate best efficient and reliable interpretations:

i) Kaiser-Meyer-Olkin measure of sampling adequacy: This measure varies between 0 and 1, and values closer to 1 are better. A value of 0.6 is a suggested minimum.

ii) Bartlett's test of sphericity: this tests the null hypothesis that the correlation matrix is an identity matrix. An identity matrix is matrix in which all of the diagonal elements are 1 and all off diagonal elements are 0. This will determine whether to reject or accept a null hypothesis.

iii) Communalities: this is the proportion of each variable's variance that can be explained by the principal components. It can be defined as the sum of squared loading factors whereby those more than 0.40 are acceptable and those below to be removed from the analysis.

iv) Initial Eigenvalues: by definition the initial value of the communality in a principal components analysis that is more than one explains the variation very well.

III. Result and Discussions

1) Situational analysis on SSFF

The respondents were all household heads of which 88.9% and 11.1% male and female respondents respectively in the study. This implies that the fish farming system dominated by male farmers. In terms of educational level 27% have gone up to primary level with 46% having secondary level and the remaining 24% having attained tertiary education level. By implication the majority of fish farmers have secondary education but the results are consistent with findings else where that fish farming does not require specialised skills.

In the fish farming business, sourcing of feed is a challenge. Hence it was imported to get the view of the participants on this aspect. Participants were asked whether feed was readily available. Of all the respondents 35% indicated that feed is readily available, 19% indicated that feed is somehow available with 38% indicating that feed is rarely available. This shows that fish feed is a challenge to a significant number of the farmers.

The farmers were then asked whether they have access to training given that this kind of venture requires onsite training. Of the respondents it was surprising to note that 78% indicated that training is not available. What can be deduced is that there is need for government and other stakeholders providing fish fingerling training to increase their visibility in terms of training provision to the farmers. It could also imply that the research institutions should be given necessary capacity for them to expand their training support on fish farming.

One area that requires serious training is handling of harvested fish. This is crucial given that fish is a highly perishable product that can easily be contaminated resulting in loss of quality and revenue. Of all the respondents 62% concurred that indeed spoilage losses is a challenge with only 38%indicating that this is not a problem. The high incidence of spoilage is consistent with the finding that majority of the farmers do not get adequate training. Fish as a perishable product requires efficient transport network to take the product to the market. When asked about this aspect 85% indicated that an efficient transport is needed for their business. This is true particularly for Namibia's environment, where temperatures are generally very high and could exacerbate fish spoilage.

The respondents were also asked about the adequacy of the marketing facilities in their respect business. Market factors are the driving force influencing aquaculture development [9]. Cumulatively 73% of the respondents believe that marketing facilities are an important component in the development of the sector. While the above provides an overview of the situation around fish farming initiatives there is still need to distill the factors influencing adoption of fish farming by the respondents. This requires a robust statistical tool that can isolate the main factors hence the PCA was used and the results are presented below.

2) Factors influencing the adoption of SSFF

The KMO was used to measure sampling adequacy and estimated about 66%, justifying the adequacy of the sampling process that led to the extraction of the nine variable extracted out of 23 variables. Bartlett's Test of Sphericity test shows that there significant level at 1% implying that variation among the variables is not the same.

The nine out of 23 variables are presented below and show the required proportion of each variable's variance that can be explained by the principal component determination.

The table below dissipates the two important interpretations of PCA, which are the Eigenvalues and loading factors within the different variances. The Eigenvalues give the percentage of variance explained in this case three components in total accounted for about 59% of variance.

Table 4 shows the structure of possible component matrix explain the motivation of farmer which would determine decision to venture to fish farming.

The first component operational systems and support for skill requirement that has high loading factors being that includes availability of Technology, running cost of fish farm, training for aquaculture and fish feed availability. This component accounted for 30.72% of the variability of decisions by the farmer to venture/continue to fish farming, as among the hindrance. Fish farming requires one to have access to technology for example technology to keep the fish products fresh as fish is a perishable product that needs to store in a proper way. This factor was among the farmers expectation to get support from government or NGOs. For example as indicated in Table 5 support for refrigerator and ice suppliers about 86.5% of the respondents indicated they are least supported. In addition to this about 78.4% of respondents indicated there is no any other direct support from the government for the issue.

In second loading factor is the farming characterisation and financial support component (that include financial assistance, anticipated size of pond and skill on fish farming). It accounted for 16.18% loading factors, this implying that access to finance restricting farmers to expand their production activities; in addition to this size of the proposed fish pond is also among the hindrance factors. These have an impact on potential revenue to be gained by the farmer. This is because of farmers as rational investors would only invest in a business as long as they anticipate good economic benefit. The issue of availability of financial assistance will go a long way in encouraging farmers to get into such a business venture. The same goes with the size of the pond whereby if the size is small then anticipated income will also be small.

3) In the third component loading factors is to do with the future enterprise outlook (that includes future plan for farming and fish feed availability) and accounted for 12.06% of the variability among farmers in terms of the hindrance factor for SSFF to continue with fish farming. But skills on fish farming are not the top priority at this point in time.

However, SSFF with regards different support services such as financial, refrigerator and ice supply, direct government support and technical support (listed on Table 5), except for technical support for the remaining shows more than 78% of the respondent indicated their disappointment by confirming they have received least support from government. Whereas, technical support by the government it was highly appreciated by farmers, about 57% of the respondent indicated government highly supportive. When it comes to refrigerator and ice supply indicated by the respondent it is minimal (86.5% indicated it is least supportive). As a result farmers either sell their produce during harvesting or otherwise drying as way of preservation. Table 6 present the summary of input supply, training opportunity, credit and information availability of input supplies; for example with regards to input supply 37.8% of the farmers responded that the input supplies is not available ; followed by 27% indicated it is available and only 16.2% shows it is readily available. This implies that farmers do not have access to input supplies in the study area which confirm the result of PCA for the first loading factors.

For fish feed availability 35.1% and 37.8% of households' responded that it is readily available and rarely available respectively (see Table 6). This simply due that the fact that government is not supplying enough fingerlings during drought for fish feed and distance from the processing plant hinders them from having access to fish feed.

For instance farmers have been supported with productive inputs and technology, with infrastructural support, with credit and market information or with support with processing and storage. All these projects and programmes however may be scattered in different geographic locations in any one country at a point in time, totally de-linked from each other thus denying farmers the synergies that different levels of support could offer. The lack of continuity in the chain of support, with production level support being subsequently complemented with support with processing and then with marketing has contributed to denying small farmers the benefits they should derive from their farming activities

Table 1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.664
Bartlett's Test of Sphericity	Approx. Chi-Square	59.956
	Df	36
	Sig.	0.007

Table 2: Communalities among the variables

	Initial	Extraction
Fish feed availability	1.000	.737
Training opportunity in aquaculture	1.000	.451
Availability of Technology	1.000	.583
Number of ponds	1.000	.349
Total yield (t)	1.000	.692
Future plans for the farm	1.000	.702
Skills on the farm	1.000	.628
Financial Assistance	1.000	.615
Running cost of the fish farm	1.000	.549

Table 3: Total Variance Explanation

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2.765	30.718	30.718	2.765	30.718	30.718	2.238
2	1.456	16.178	46.896	1.456	16.178	46.896	1.424
3	1.086	12.063	58.960	1.086	12.063	58.960	2.099
4	.987	10.964	69.924				
5	.868	9.645	79.568				
6	.601	6.673	86.241				
7	.465	5.165	91.406				
8	.421	4.677	96.083				
9	.353	3.917	100.000				

Extraction Method: Principal Component Analysis.
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 4: Structure Matrix

	Component		
	1	2	3
Availability of Technology	0.761		
Running cost of the fish farm	0.736		
Training opportunity in aquaculture	0.663		
Financial Assistance	-0.376	0.710	
Total yield (t)	-0.430	-0.671	
Size of ponds	-0.419	0.436	
Future plans for the farm			0.838
Fish feed availability	0.331		0.825
Skills on the farm		0.487	-0.683

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Table 5: Summary of support services for SSFF (in percentage)

Description	**Highly supportive in (%)**	**Supportive in (%)**	**Least supportive in (%)**	**NWT in (%)**
Support by Financial Institutions	2.7	8.1	81.1	8.1
Support by Refrigerator and ice suppliers	2.7	2.7	86.5	8.1
Direct support by the government	8.1	5.4	78.4	8.1
Technical support by the government	56.8	29.7	5.4	8.1

Table 6: Summary of availability support services (in percentage)

	Not Sure	**Readily Available**	**Available**	**Not Available**	**N/A**
Availability of input supplies	8.1	16.2	27	37.8	10.8
Fish feed availability	35.1	18.9	37.8	91.9	8.1
Seed availability for farming	48.6	35.1	8.1	91.9	8.1
Training opportunity in aquaculture	8.1	8.1	78.4	5.4	

Availability of credit	2	32	34	3	
Information on aquaculture	8.1	10.8	13.5	59.5	8.1
Accessibility of markets	8.1	10.8	29.7	45.9	5.4
Availability of storage facility	8.1	8.1	13.5	64.9	5.4
Distribution Centre	10.8	24.3	56.8	91.9	8.1

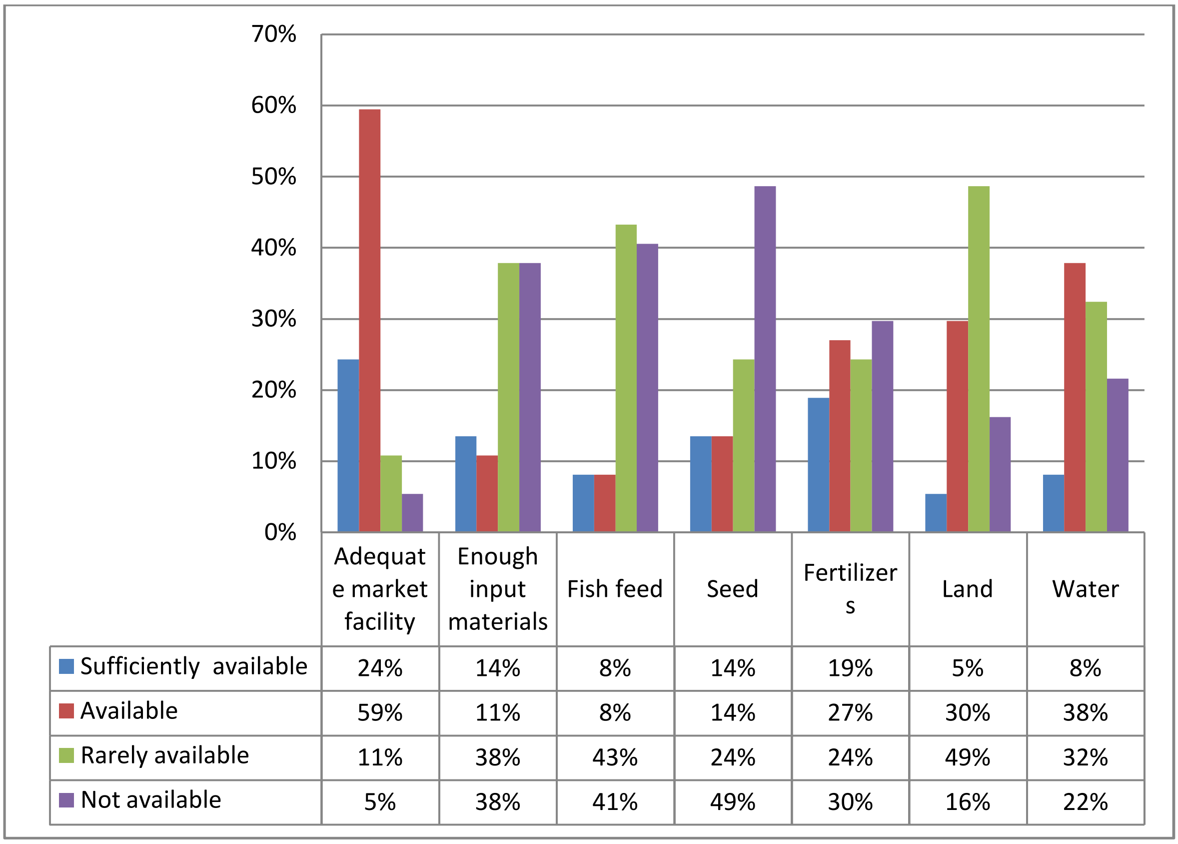

Fig.1. Support service for small scale fish farming

IV. Conclusion and Recommendations

The situational analysis on small scale fish farming situation, including training opportunity transport and marketing; this study shows that aquaculture will not be sustainable if not managed as such well. This includes incorporating production, processing, storage and distribution. Production and marketing infrastructure that includes cold-chain storage hampered by poor electricity supplies; an unreliable transportation network; competition from cheap imports and lack of processing industry for the capability to add value are among the major challenges among SSFF in Namibia.

Small farmers can increase their effective size and bargaining powers joining their effort in the form of cooperatives, allowing for economic of scale and lower marketing costs by pooling resources and negotiation efforts.

The structure of possible component matrix explains the hindrance factors for farmer which would determine decision for farmers to continue. The first component operational systems and support for skill requirement has found to have high loading factors being (that includes availability of Technology, running cost of fish farm, training for aquaculture and fish feed availability). This component accounted for 30.72% of the variability of hindering factors.

In second loading factor farming characterisation and financial support component (that include financial assistance, anticipated size of pond and skill on fish farming); It accounted for 16.18% loading factors, this implying that access to finance restricting farmers to expand their production

The third component loading factors is to do with the future enterprise outlook (that includes future plan for farming and fish feed availability) and accounted for 12.06% of the variability among farmers in terms of the hindrance factor for SSFF to continue with fish farming. Whereas, in this component required skill for farming become is not an issue to continue

Even though government of Namibia supplying tilapias for free to the fish farmers, however, it is highly recommended:

- To strengthen technical and organizational (fish farmers associations, groups, cooperatives) capacity of fish farmers
- Strengthen producers' understanding of aquaculture socio-economic aspects (business plan, record keeping, etc.) and assist them with business plans for aquaculture

- Provide public sector support to private entrepreneurs in setting up the technological infrastructure required for aquaculture (e.g. cold chains, storage facilities, etc)

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