Vol. 13(2), pp. 56-66, July-December 2021
DOI: 10.5897/IJFA2021.0785
Article Number: 222642968129
ISSN 2006-9839

http://www.academicjournals.org/IJFA

ACADEMIC JOURNALS
expand your knowledge

International Journal of Fisheries and Aquaculture

Full Length Research Paper

Cost-benefit analysis for small-scale aquaculture production systems: A case of South West Region of Cameroon, Africa

Majory O. Meliko[1*], Siri B. Ngoh[2] and Justin N. Okolle[2]

[1]Department of Agricultural Economics and Agribusiness, Faculty of Agriculture and Veterinary Medicine, University of Buea, Cameroon.
[2]Agricultural Research Institute for Development, Ekona, Cameroon.

Received 22 June, 2020; Accepted 4 February, 2021

Food is necessary for good health as well as the social and political stability of the society. Fish food provides essential nourishment especially proteins of high biological values. It is highly nutritious, tasty and easily digestive. Enterprise budgeting and descriptive statistics were used to estimate the value of smallholder aquaculture systems on a census population using a semi-structured questionnaire in the South West Region of Cameroon, Africa. It was established that aquaculture is a marginal activity in the region with less than 41 active farmers. 100% of the famers were male with 84.4% above 45 years and 71.9% of them had more than primary level education. The farmers produce only Tilapia (34 tons) and Catfish (49 tons) mainly in small sized pond with statistical mode of 25 m^2. All the aquaculture productive systems, extensive, semi-intensive and intensive systems were profitable and significantly different from zero (P <0.01). The variable costs of all the systems were more than 50% to total cost indicating little investment in modern technologies, rendering them traditional. The farmers, therefore, had potentials to increase productivity with targeted training and increase accessibility to fingerlings. However, it was concluded that since aquaculture is profitable, an enabling policy is necessary to increase participation of farmers especially women and youth in order to empower them economically.

Key words: Aquaculture, production systems, cost benefit analysis, Cameroon.

INTRODUCTION

Capture fishery production has been relatively static since the late 1980s, while aquaculture - defined as the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants in selected or controlled environments - has been responsible for the impressive growth in the supply of fish for global human consumption (Kaktcham et al., 2015). Zhou (2017) reported that there are 591 aquatic species and species groups which have been farmed in inland freshwater, inland saline water, coastal brackish water and marine water.

*Corresponding author. E-mail: Melikiomo@yahoo.com.

In the course of half a century or so, aquaculture has expanded from being almost negligible to being an equal with capture production in terms of feeding the world's population. It accounts for half of the world seafood supply and a large portion of its products are traded across borders. Over 90% of the total global aquaculture production is from developing countries (European Union, 2013).

Aquaculture has become an agronomic activity with noticeable development around the world (Vélez, 2017). It is considered as an important provider of much needed high quality animal protein generally, at prices affordable to the poorer segments of society and has established itself as a significant contributor to poverty alleviation, food security, income generation, economic growth and ensures better use of natural resources in many societies (European Union, 2013; FAO, 2017; Ottinger, 2018). This is because commercially oriented aquaculture production can increase foreign exchange, generates national revenue through taxes and improves employment, while the extensive forms can benefit the livelihoods of the poor by improving the quality of their diet, reduce their vulnerability to aquatic products, and increase their income (Bondad-Reantaso et al., 2005; Boto et al., 2013). However, more than 40 years of its practice in sub-Saharan Africa, aquaculture still remains a marginalized activity. The main causes of difference in development may be attributed to lack of motivation of the farmers, inputs, climate, management, technology, markets, social environment and institution (Toguyeni, 2004; Nadarajah and Flaaten, 2017; Amundsen et al., 2019)

Seafood is important to the diet because of its contribution in terms of animal protein and micro nutrients (Nadarajah and Flaaten, 2017). Fish represents an important source of animal protein for some 400 million Africans, contributing essential proteins and micronutrients to their diets (Boto et al., 2013). It is highly nutritious, tasty and easily digestible. In addition, fish provides essential fats (long-chain omega-3 fatty acids), vitamins (A, B and D) and minerals (calcium, iodine, zinc, iron and selenium), particularly if eaten whole (Sujatha et al., 2013). Fish foods have nutritional profiles superior to terrestrial meats and more sustainable production technology compared to other animal proteins production (European Union, 2013; Amundsen et al., 2019).

The quality of a protein depends on its ability to provide nitrogen to meet the amino acid requirements, which in turn, is determined by the protein's digestibility and amino acid profile (European Union, 2013). Protein can be obtained from both plant and animal sources. According to Boto et al. (2013), the quantity and quality of protein from animal-based food products contain the highest amount of protein per unit energy and is also considered the best quality protein as it provides all the essential amino acids for the diet in adequate proportions. Unlike protein from plant sources, animal based proteins have no factor inhibiting the absorption of vitamins and minerals in the body. Protein-energy malnutrition (PEM) is the most basic kind of malnutrition and is the result of lack of carbohydrates, fats or proteins in a diet (WFP, 2016). It is accepted that the best way to fight malnutrition in Africa is to add small amounts of animal proteins to plant based diets. This may prevent deficiencies, with various beneficial health outcomes, such as weight management, muscle mass maintenance, prevention of osteoporosis and reduction of the risks of cardiovascular diseases, improvement of maternal health and child development (IFIC, 2011; Boto et al., 2013) .

Fish is much sought after by a broad cross-section of the world's population, particularly in developing countries. Capture fisheries and aquaculture supplied the world with about 148 million tonnes of fish in 2010 at a growth that out space that of the world's population (Boto et al., 2013). According to FAO (2018), over 3.2 billion people worldwide derived 20% of their animal protein intake from fish. Sujatha et al. (2013) reported that around 60% of people in many developing countries depend on fish for over 30% of their animal protein supplies. According to Du Preez (2018), about 200 million Africans depend on fish for their supply of cheap protein mostly from small-scale suppliers. 10 to 19 million of them derive their livelihood directly on fishing and about 90 million on diverse strategies.

Fish is the most preferred source of protein for the under-privileged Cameroonian because it is cheap and available in convenient small portions. It consist of more than half of the animal proteins consumed in Cameroon and it was estimated to reach 400,000 tons in 2015 (Ayissi and Jiofack, 2014; Kaktcham et al., 2015). Although, aquaculture was introduced in Cameroon since 1948, the sector has remain stagnated with only about 10,000 aquaculture farmers who are engaged mainly on part-time basis and are producing about 1000 tons from the 176,000 tons of fish produced by the fisheries industry in the country (FAO, 2015). Also, Folack et al. (2000) reported that in 1965, Cameroon had 10,000 fishponds but there are only 5,300 fishponds now available. Due to the fact that the domestic fish production cannot meet demand, Kaktcham et al. (2015), stated that the government actually spends over 100 billion FCFA (200 million USD) annually on fish imports and that 230,000 tons of fish were imported in 2013.

There is great potential for fish culture within Cameroon, endowed with a dense river network with many estuaries, natural reservoirs and lakes having a high potential for fish culture and biodiversity conservation, which may provide an opportunity to contribute to the external balance of trade for fishery products and to satisfy national demand (Folack et al., 2000). The Government of Cameroon has recognised these potentials and it is trying to revive its aquaculture industry. The sector has become a priority for the government which has drawn up a strategic framework for sustainable aquaculture development, and is revising the legal framework governing fisheries and aquaculture in Cameroon. Within these contents, it intends to increase production to more than 100,000 tons annually in order to meet the strong demand of its escalating population by curbing the massive importation of fish thus, reducing the outflows of foreign exchange (FAO, 2015).

Increasing production increases the chances that the industry will face emerging biological, economic and social challenges (Føre et al., 2017). The economic viability and its contribution to the welfare of the farmers and the country in general will determine the sustainability of development in the aquaculture sector. Therefore, constant and continuous socio-economic assessment is necessary to provide information for better understanding of smallholder aquaculture farmers and the farming system in the South West Region so that the government can improve its policy to increase adoption of the technology and consequently aquaculture production. The main objective of this study is to estimate the value of small-holder aquaculture farming to the South West Region of Cameroon by determining the socio-economic parameters associated to aquaculture production, identifying the management practices of aquaculture farming, estimating the profitability of aquaculture farming and determining the contribution of aquaculture to the economy.

MATERIALS AND METHODS

Study area

The study was carried out in the South West Region of Cameroon, Africa. Situated in the Equatorial Rain Forest, the South West Region is one of the ten regions of Cameroon. It is also one of the two English-speaking regions (with the North West Region) covering an area of 24,571 km^2. The South West Region has an estimated population of 1.5 million inhabitants and a population density of 58 persons/km^2 and over 70% of the inhabitants live in rural areas and are engaged in agriculture (MINADER, 2013).

The region is divided into six divisions of Fako, Kupe Mauneguba, Lebialem, Manyu, Meme, and Ndian. It is bordered in the west by Nigeria, to the north by the North West Region, to the east by the Littoral and West regions and to the South by the Atlantic Ocean. The region is endowed with fertile volcanic soils in Fako to rich clayey soils in Manyu division. It is rich in fishery, forestry and wildlife resources with the production of diverse agricultural commodities and plantation crops.

Data collection

A census was conducted from a list of aquaculture famers provided by the South West Regional Delegation of Livestock, Fisheries and Animal Husbandry for the production period 2016/2017. The entire South West Region has only 77 registered fish farmers. Of the 77 registered fish farmers on the list, 36 farmers were either inactive (not producing for the production period) or have abandoned the technology leaving only 41 active fish farmers.

During data collection, it was found that of the 41 active registered farmers reported on the list, two (2) farmers had also abandoned production and three (3) other farms had merged to one administration, giving a total of thirty-seven (37) active farms in the entire region. However, due to logistics, the three (3) farms listed as active in Kupe Mauneguba were not interviewed and two (2) other farm owners were not available for questioning during the 2017/2018 production period. In all, data from 32 farmers were analysed belonging to three divisions namely, Fako (9), Lebialem (8) and Meme (15) giving a total of 86.5% farmers who were surveyed.

Data analysis

The aquaculture enterprises were classified as intensive, semi-intensive or extensive based on the feeding regimes. Intensive production was for the category of farmers using solely compounded or commercial feeds to feed their fish, semi intensive was used to categorise farmers using both commercial/ compounded feeds and waste (kitchen or animal) to feed their fish, while extensive production systems was categorised as farmers using only waste. The study employed descriptive statistics in the form of frequencies and cross-tabulation to test for significance in Statistical Product and Service Solutions – SPSS Version 20.0 software, an IBM product since 2009 (Hejase and Hejase, 2013). The enterprise budget analyses was used to analyze profitability

Descriptive statistics

Descriptive statistics in the forms of frequencies, percentages, and means were used to describe the variables. Chi square (χ^2) were used to test for significance for association among variables.

Profit analysis and test of significance

An enterprise budget was used to examine profitability of the enterprises by considering the returns to the farmers' resources, which consist of the annual income minus the annual cost of hired labour, capital (construction cost of ponds and dams and purchase of fixed equipment), and other variable production inputs. The mean profits of the various production systems were compared using one sample t-test.

RESULTS AND DISCUSSION

Socio-economic variables

The development and adoption of aquaculture can provide benefits for livelihood improvement, food security and poverty alleviation through income generation, employment, diversification of farm practices and trade to both the famers and the nation (Bondad-Reantaso et al., 2005, Kaminski et al., 2020). Socio-economic assessment can provide a better understanding of small-farming systems, identify constraints preventing higher productivity and also identify the specific needs of the farmers.

According to Skirbekk (2003), the physical and mental abilities, education and job experience form an individual's productivity potential. As can be seen from the results in Table 1, majority (84.4%) of the farmers are older than 45 years while there is none below the age of 30 years. The fact that there is no farmer under the age of 30 years indicates that there may be succession problem which may affect the survival of an already fragile aquaculture sector. This is because in the absence of young people in a production process, local knowledge and those gained through trial and errors may not be transferred to the future generations. More so, youths tend to accept and adopt technology faster than the elderly (Mueller et al., 2019) which are indications of increase productivity. The relatively old farmers suggest that the overall efficiency of the enterprises may be compromised. This is in relation to the fact that job performances have the highest productivity between the ages of 40 and 49 and decrease from 50 years of age (Converso et al., 2018; Holzhausen et al., 2019).

However, Skirbekk (2003) also argued that targeted training programmes could be effective in softening, or halting age-related decline. Such training could be obtained from extension visit, through association or formal education. Gunasena (2003) asserted that even illiterate men and women can learn new skills rapidly provided that the training is relevant. This is projected to the characteristics of these farmers because 71.9% of them have above primary educational profile similar to that reported by FAO (2015).

Therefore, if these farmers are provided with relevant training combined with improved technology, they may improve their productivity and consequently obtain higher income from increased marketable surplus. This statement is justified by the FAO (2004) report, which states that a farmer with four years of elementary education is almost 9 % more productive than a farmer with no education.

In addition, the results revealed that farmers in the South West Region had a maximum of 26 years' experience of operating in aquaculture with an average of 8 years. With these levels of experience, one should expect increasing productivity. This is because most farming decisions are based on knowledge of local soil and weather conditions, learning through trial and error (Skirbekk, 2003; MacDonald et al., 2007), which the farmers are expected to have mastered based on the time they have participated in aquaculture production process in this region.

The household is the basic economic unit and agricultural production decision may be determined by household dynamics. According to Ngeywo et al. (2015), marital status is a major determinant in the level and magnitude of hereditary conflicts and thus a factor affecting good agricultural practices. 90.6% of the respondents are married. This indicates that aquaculture is an activity carried out by responsible men who respect the institution of marriage. As postulated by Ifejika et al. (2007), the marital status is an indication of the family responsibility shouldered by the farmer. Combined with the fact that 68.8% of the farms solely used family labour in their activities indicates that there is synergy among household members which assured continuity in aquaculture production. Also, because family labour economizes on recruitment and supervision costs, seemingly, the aquaculture production in South West Region could be labour efficient (Roumasset, 2003).

Women constitute the main agricultural labour force in Africa. Ironically, men cultivate larger areas and produce more agricultural goods because they have access to more resources and better technology (Rwelamira, 1999). This study confirmed the previous statement as 100% of the participants are male. Similar finding was reported by FAO (2015) with 90% male participation in aquaculture for Cameroon. Ngeywo et al. (2015) reported comparable gender bias in catfish farming in Kisii county of Kenya where they found male dominance (82.5%) in the aquaculture production process. This may be because women are considered to be producers of food while their male counterparts concentrate on cash crop and livestock production with little interest on women to become stock farmers (Rwelamira, 1999; Zakaria, 2017). It may otherwise be due to the traditional customs of Cameroon which do not allow women to inherit land (FAO, 2015).

Despite the potential (from the socio-economic profile) of the famers to improve productivity thereby making aquaculture more attractive, the up-take of the technology has been very timid as only 77 identified (both active and inactive) farmers had ever participated in aquaculture production in the whole of the region. This is in conformity with Toguyeni (2004) who reported low development in aquaculture in sub-Saharan Africa. Based on these findings, policies agenda should be put in place to motivate and create avenues especially for women and youths to participate in aquaculture in order to meet government production objectives and also for the sustainability of the sector.

Production systems

This study found out that in farmers in the South West Region, only two types of fish *Clarias gariepinus* (catfish) and the *Oreochromis niloticus* (Tilapia) were the dominant species produced.

Based on the classification of the aquaculture production systems into intensive, semi-intensive and extensive systems, it can be seen in Table 1 that 40.6% of the farmers are practising semi-intensive production system. In Table 2, the most common production practice is solely tilapia (56.2%). This could be an implication in the availability of fingerlings which was reported as a major problem by the respondents.

Catfish does not reproduce freely in captivity like tilapia. For it to reproduce in captivity, specialized techniques are needed, which the farmers need to adopt. These

Table 1. Distribution of the socio-economic characteristics of aquaculture farmers of the South West Region.

Variable	N	Frequency	Percentage
Type of farming system			
Extensive		12	37.5
Semi-intensive	32	13	40.6
Intensive		7	21.9
Division			
Fako		9	28.1
Meme	32	15	46.9
Lebialem		8	25.0
Sex			
Male	32	32	100
Female		0	0
Age			
30-45		5	15.6
46-60	32	17	53.1
>60		10	31.3
Educational level			
Primary		9	28.1
Secondary		15	46.9
Tertiary	32	8	25.0
Marital status			
Never married		1	3.1
Married		29	90.6
Divorced	32	1	3.1
Widower		1	3.1
Source of labour			
Family	32	22	68.8
Hired		10	31.3
Main occupation			
Farming		25	78.1
Agriculture professionals	32	5	15.6
Other		2	6.3
Variable	**N**	**Mean**	**Maximum**
Experience	32	8 years	26 years

technologies are associated with additional costs and new skills. Due to the fact that none of the extensive farmer produces catfish (however, 91.7% of them produce tilapia), indicates that the additional cost may be one they may not want to incur. Therefore, to encourage the production of catfish, a hatchery should be put in place either by government or private enterprise in close proximity to the fish farms.

From the non-parametric Chi-square (χ^2) results obtained from cross-tabulation presented in Table 3, there exist divisional preferences (P<0.05) on the types of production systems practised in the region. This could be an indication on the availability of fingerlings, as it was noticed that most of the farmers got their fingerlings

Table 2. Frequency of fish farming.

Type of fish farming	Percentage (Frequency)			
	Extensive	Semi-intensive	Intensive	Total
Catfish only	00 (0)	23.1 (3)	42.9 (3)	18.8 (6)
Tilapia only	91.7 (11)	46.2 (6)	14.3 (1)	56.2 (18)
Both Catfish and Tilapia	8.3 (1)	30.8 (4)	42.9 (3)	25.0 (8)
Total	37.5 (12)	10.6 (13)	21.9 (7)	100 (32)

Table 3. Chi-square results of socio-economic variables with farming systems.

Variable	χ^2	Significant
Division	23.877	P≤ 0.01
Age	1.634	P≥ 0.05
Educational level	15.927	P≤ 0.01
Occupation	21.238	P≤ 0.01
Member of association	6.795	P≤ 0.05

especially of catfish from Limbe in Fako Division. This may be supported by the fact that no producer in Lebialem Division which is at least 270.1 km far from Limbe with about half the stretch of its roads rough and hilly produced catfish. 50% of the intensive producers were from Fako Division with the remainder from Meme Division, which is about 94.1 km from Limbe with better road network.

The results also showed that except of the age of the farmers, significant relationships existed between educational level, main occupation of farmers and member of an association with the type of production systems. The aforementioned factors are all skill determining variables. These results are all as expected because more educated farmers, farmers with agricultural background and farmers affiliated to an association should be geared towards intensive farming. This therefore, supports the fact that with additional relevant training, the farmers may likely improve on their productivity and consequently production and income. Thus, policies need to be put in place to intensify extension services (from all relevant sectors involved) to boost training and to sensitize the rural population especially those without alternative employment on the benefit of aquaculture.

Management practice

For any production system to be successful, a systematic and efficient management practice needs to be adopted by the farmer. According to Ozigbo et al. (2014), the major management practices necessary for effective aquaculture production are fish stocking density, feeding, water quality control, diseases control and record keeping. The activities below attempt to capture some of these principal management practices.

Catfish are slow growers and their predatory nature significantly suppresses the stocking density. On the other hand, tilapias are very prolific breeders which can grossly increase the stocking density of the fish ponds. Therefore, to manage stocking density, farmers either calibrate (separate bigger fishes from the smaller ones) their fish farms or drop maggots into the ponds to mimic smaller fish. From the results in Table 4, a cumulative 21.9% of the producers prevent cannibalism with 18.8% practicing calibration and 3.1% engaged in maggot dropping. A whopping 78.1% of the producers do nothing to prevent cannibalism.

Regular weighing is another activity that aids in the control for stocking density. This is because it is through weighing that calibration can be done. Weighing can also be considered an activity in record keeping. Therefore, all those who weigh regularly keep such records. Record keeping on weight may help in identifying stocking performance which in turn may help identify the best source of fingerlings. From the result, up to 84.4% weighed their stock only during harvest and only 6.3% do so more than once a month. Weighing during harvest implies that the majority of the producers weigh only to sell.

Cleaning the ponds takes care of disease and water quality control. Producers can clean their ponds by changing water from the ponds or using cleaning agent (chemicals) to prevent disease build-up and turbidity. Regular water exchange implies that less chemicals are

Table 4. Type of management practices in South West aquaculture.

Variable	N	Frequency	Percentage
Prevention of cannibalism	32		
Calibration		6	18.8
Maggot dropping		1	3.1
Nothing was done		25	78.1
Fish weighing	32		
More than once a month		2	6.3
Once every 1-3 months		3	9.4
During harvest		27	84.4
Cleaning (water exchange) per production)	27		
Once		11	40.7
Twice		6	22.2
Thrice		2	7.4
Quarterly		3	11.1
More than four times		5	18.5
Number of ponds owned	32		
1		10	31.3
2		8	25
3		6	18.8
4		3	9.4
More than 4		5	15.6

Table 5. Chi square result on management practices with farming systems.

Variable	χ^2	Significant
Number of pond	14.512	P≥ 0.05
pond cleaning	18.949	P≤ 0.05
Cannibalism	17.952	P≤ 0.01
Fish weighing	12.933	P≤ 0.05

used to prevent disease and to control the water pH. Thus, the fish are “healthier” and the environment may be cleaner. However, 40.7% of the producers exchange their pond water only during harvest.

The number of ponds owned by a producer is an indication of the capacity of the farm and an instrument to control for stocking density. In addition, it can be used to ease calibration, weighing and cleaning. The fact that 31.3% of the producers had only one (1) pond may be an indication while most of them do not calibrate, regularly weigh their fish and clean their ponds.

From the results in Table 5, it can be seen that all the management variables except for the number of fish ponds a farmer owns, had significant association ($P < 0.05$) with farming system. Although these represent better fishpond management for intensive production systems compared to extensive production systems, the overall percentage of good management practiced by most of the respondents were very poor. The socio-economic results of these farmers indicated that the respondents are well educated and therefore have the ability to comprehend and adopt new technologies. It is therefore, recommended that these farmers should be schooled on how to better manage their fishponds in order to improve on their productivity.

Profitability

Profit defined as the difference between revenues and costs, provides an incentive for increase innovation and investment in agriculture on both farmers and national

Table 6. Profitability result of aquaculture farming systems.

Variable	Extensive	Percentage cost	Semi intensive	Percentage cost	Intensive	Percentage cost
Pond size	25 m^2	-	25 m^2	-	25 m^2	-
Income						
Sales of fish	65311.15	-	62161.17	-	396047.8	-
Variable inputs						
Feed cost	0.00	0 (0)	3530.75	45.91 (23.13)	206622.5	71.14 (62.33)
Cost of fingerlings	3979.26	70.07 (49.40)	1685.73	21.92 (11.04)	36000.68	12.44 (10.86)
Labour cost	1232.29	21.70 (15.30)	2149.3	29.94 (14.08)	39981.84	13.81 (12.06)
Other cost	467.24	8.23 (5.80)	324.5	4.22 (2.13)	6801.43	2.35 (2.05)
Total Variable cost	*5678.79*	*(70.05)*	*7690.28*	*(50.38)*	*289406.50*	*(87.31)*
Gross profit	59632.36	-	54570.89	-	106641.3	-
Gross profit margin	91.30%	-	87.79%	-	26.93%	-
Fixed inputs						
Equipment cost	89.00	3.74 (1.10)	797.49	10.53 (5.22)	5125.54	12.18 (1.55)
Catchment cost	38.51	1.62 (0.48)	289.73	3.83 (1.90)	769.42	1.83 (0.23)
Pond cost	2248.92	94.63 (27.92)	6485.83	85.64 (42.49)	36178.48	85.99 (10.91)
Total fixed cost	*2376.43*	*(29.50)*	*7573.05*	*(49.62)*	*42073.44*	*(12.69)*
Total Cost	*8055.22*	-	*15263.33*	-	*331479.9*	-
Net profit	57255.93	-	46897.84	-	64567.86	-
Net profit margin	87.67%	-	75.45%	-	16.30%	-
Return on investment	7.11	-	3.07	-	0.19	-

Figures in parentheses represent cost percentage of total cost while otherwise it is with either total variable cost or total fixed cost. Prices and cost are in Franc "Coopération Financière en Afrique Central" FCFA.

perspectives. The complexity of factor interactions in agricultural production may give rise to a series of benefits and costs which warrant constant monitoring.

For the purpose of this study, from the data collected, the production size of the enterprises budget for the fishpond used was 25 m^2, which was the statistical mode of the fishpond sizes from the survey. Due to the extensive nature of some of the activities, it was difficult to quantify family labour. Therefore, family labour was assumed as part of profitability whereas, hired labour was treated as cost. Since most of the capital acquisitions were construction (that is physical structures), annual depreciation of the fixed input was done using the straight-line method and the cost and selling prices were the actual money value in "Franc Coopération Financière en Afrique Central" (FCFA).

Table 6 displays the profits for the three farming systems which are inclusive of the returns from capital, management and family labour.

Profitability attracts a growing number of smallholders to venture into cultivation (Basiron, 2007). All the production systems recorded positive gross and net profits. The gross margin from intensive production system (106,641.3 FCFA) was almost double that of the semi-intensive production system (54,570.89 FCFA) and extensive production systems (59,632.36 FCFA). However, the gross profit margin was far higher for extensive (91.3%) to that of semi-intensive (87.79%) and intensive (26.93%). Gross profit margin is interpreted for the case of extensive production system as, for every 1 FCFA income realised, the farmer makes a gross profit of 0.91 FCFA. This therefore means that extensive production system makes the highest proportion of profit.

Also, all net profits were positive: intensive (64,567.86 FCFA), extensive (57,255.93 FCFA), and semi-intensive (46,897.84 FCFA). Likewise, the net profit margin for extensive production (87.67%) was the greatest compared to semi-intensive (75.45%) and intensive (16.30%) production systems. A significant t-test ($P < 0.01$) implies that all the profits were significantly different from zero. This confirms that it is practically feasible to obtain profit in any aquaculture production system in the South West Region. With an enabling policy, these positive profits could be an incentive to the youths. Furthermore, an increase in the number of farmers entering the sector due to profit motivation may lead to expansion thereby increasing the production of food fish, reducing importation and consequently the imbalance on

Table 7. Production of fish in South West Region.

Statistics	Pond size	Quantity of Tilapia	Quantity of *Clarias* (Catfish)
N	30	32	32
Mean	645 m^2	1066 kg	1534 kg
Sum	19335 m^2	34097 kg	49085 kg

trade.

Results in Table 6 showed that the percentage of variable costs in all production systems accounted for more than 50% of total cost (intensive (87.31%), semi-intensive (50.38%) and extensive (70.05%)). What can be deduced from this is that these farmers were very traditional in their production as less was invested on fixed input. It is presumed that they do not use modern technologies, thereby losing from the gains which improved technologies could have contributed to their production process. Looking at the individual variable inputs' contribution to the total variable cost, fingerlings (70.07%) constituted the most cost item for extensive production systems. The cost of feeds was the highest contribution to variable cost for both semi-intensive (45.91%) and intensive (71.14%) production systems. In turn of contribution of production inputs to the total cost, feeds constituted the highest (62.33%) cost contributing item for intensive systems while the cost of constructing ponds was the highest for semi-intensive systems (42.49%) and fingerlings (49.40%) for extensive systems. These items that contributed the highest to costs (total variable and total cost) serve as indication on where these farmers need to pay attention when looking for ways to minimize cost and consequently increase profit.

The returns on investment were 7.11, 3.07 and 0.19% for extensive, semi-intensive and intensive production systems, respectively. This indicates that extensive producers are more efficient in managing their resources compared to semi-intensive and intensive. This is expected, because apart from feeding, there is little difference in investments in the practices of the different production systems which include little mechanization, poor quality fingerlings and poor fishpond management.

Contribution to the economy

The findings revealed that there are about 106 fishponds in the South West Region. The results depicted in Table 7 showed that ponds covered a total area of about 19335 m^2 of which 383 tons of fish were produced in an average fishpond size of 645 m^2. Bigwa (2013) reported 7,500 ponds on average size of 350 m^2 with an annual production estimated at 870 tons for the whole Cameroon in 2006. It can also be seen that the average pond size in the region is almost twice the size of the average Cameroonian aquaculture farmer in 2006 but produces about a tenth of the countries production at the time. Bigwa (2013) reported more tilapia being produced than catfish (450 tons of tilapia, 350 tons of catfish) in Cameroon, contrary to this study which found out that in the region, there were more catfish (49 tons) produced than tilapia (34 tons). Looking at the results, the production of food fish (83 ton) in the South West Region is a far cry from the estimated 100,000 tons (FAO, 2015) the government is targeting annually. In order to meet this target, production must be taking place heavily in other regions or the government needs to steepen its policies to stimulate production.

Conclusion

Little attention is given to aquaculture as a production technique among smallholders in the South West Region as can be seen in the number of producers involved (77 registered with 41 active). The production is still very traditional with little mechanization, poor fishponds management, poor quality fingerlings and production thousands of times less than what the government is expecting. Moreover, women and youth are absent in aquaculture production in the region. Nonetheless, majority of the farmers are educated, have long term experience, belong to an association and use family labour. Therefore, there is potential for increase in productivity and consequently production.

Given that aquaculture is profitable in all its production systems, more farmers are encouraged to adopt the technology which may increase production, their income and food security. However, good management practices are essential for improving quality and quantity of catch and therefore higher profits. Changes in management practice can be influenced by awareness which may be obtained from interaction with family, peers and experts. Training and producers' organisations are opportunities for such interactions. Extension services are therefore, recommended to facilitate training and creation of producers organisation, and to provide additional information to farmers.

The absence of women and youth in the production system indicates gender bias, which may be as a result of social, cultural, and or biological differences. Women and young people usually occupy lower social status in the community. They are restricted in the hereditary process which in turn limits their access to capital. Addressing their leadership in economic activities is crucial for their participation in aquaculture. Therefore, policies to empower women and youth by improving on their skills, equal access to assets and information should be implemented.

Policies to improve production have their intended and unintended benefits and cost to the welfare of community. Although, higher production/profits are consequences for improved socio-economic conditions, the socio-economic, production practices and policies also have a lot to do with the outcome of production. Therefore, further research is needed on (i) the impact of the various policies on the production of aquaculture and (ii) the factors influencing aquaculture production/profit in the South West Region.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

This research was sponsored financially by the Forum for Agricultural Research in Africa (FARA), in partnership with the German Government represented by the Center for Development Research (ZEF) of the University of Bonn

REFERENCES

Amundsen VS, Gauteplass AÅ, Bailey JL (2019). Level up or game over: the implications of levels of impact in certification schemes for salmon aquaculture, Aquaculture Economics and Management 23(3):237-253.

Ayissi I, Jiofack TJE (2014). The Impact Assessment on By-catch Artisanal Fisheries: Sea Turtles and Mammals in Cameroon, West Africa. Fisheries and Aquaculture Journal 5:3.

Bigwa C (2013). Feasibility of Aquaculture in Cameroon: The Case of the Noun Division in the West Region. Final Project. www.unuftp.is/static/fellows/document/charlotte12prf.pdf

Bondad-Reantaso MG, Subasinghe RP, Arthur JR, Ogawa K, Chinabut S, Adlard R, Tan Z, Shariff M (2005). Disease and health management in Asian aquaculture. Veterinary Parasitology 132(3-4):249-272.

Boto I, Phillips S, D'Andrea M (2013). Fish-farming: the new driver of the blue economy. Brussels Rural Development Briefings 32:21.

Converso D, Sottimano I, Guidetti G, Loera B, Cortini M, Viotti S (2018). Aging and work ability: the moderating role of job and personal resources. Frontiers in Psychology 8:2262

Du Preez MI (2018). Gender and small-Scale Fisheries in Africa. Policy Brief 173, South Africa Institute of International Affairs (SAIIA) 4 p.

European Union (EU) (2013). Enhancing Maternal and Child Nutrition in External Assistance: an EU Policy Framework. Communication from the Commission to the European Parliament and the Council. European Commission, Brussels 14 p.

Folack J, Gabcheand CE, Chiambeng GY (2000). Fish culture potential and biodiversity conservation in the Cameroon coastal zone, p. 44-47. In: Abban EK, Casal CMV, Falk, Pullin RSV (eds.) Biodiversity and sustainable use of fish in the coastal zone. ICIARM Conference Proceedings 63, 71 p.

Food and Agriculture Organization (FAO) (2015). National Aquaculture Sector Overview: Cameroon. http://www.fao.org/fishery/countrysector/naso_cameroun/en

Food and Agriculture Organization (FAO) (2017). FAO and the SDGs. Indicators: Measuring up to the 2030 Agenda for Sustainable Development. FAO, Rome 39 p.

Food and Agriculture Organization (FAO) (2018). The State of World Fisheries and Aquaculture: Meeting the Sustainable Development Goals. Food and Agriculture Organization of the United Nations, Rome Pp 227

Food and Agriculture Organization (FAO) (2004). Education for rural people to boost agricultural productivity in Latin America. www.fao.org/newsroom/en/news/2004/49012/index.html

Føre M, Frank K, Norton T, Svendsen E, Alfredsen JA, Dempster T, Eguiraun H, Watson W, Stahl A, Sunde LM, Schellewald C (2017). Precision Fish Farming: A New Framework to Improve Production in Aquaculture. Biosystems Engineering 173:176-193.

Gunasena HPM (2003). Food and poverty: Technologies for poverty alleviation. South Asia Conference on Technologies for Poverty Reduction, New Delhi 10 -11 October P 21.

Hejase AJ, Hejase HJ (2013). Research Methods: A Practical Approach for Business Students (2nd edition). Philadelphia, Masadir Inc, P 660.

Holzhausen A, Michler C, Romero PP (2019). Aging: A Fountain of Youth for Productivity Growth. The View by Economic Research. Euler Hermes Allianz Economic Research 8 p.

Ifejika PI, Ayanda JO, Sule AM (2007). Socio-Economic Variables Affecting Aquaculture Production Practices in Borgu Local Government Area Of Niger State, Nigeria. Journal of Agriculture and Social Research 7(2):20-29

International Food Information Council (IFIC) Foundation (2011). Protein and Health: Fact sheet. www.foodinsight.org

Kaktcham PM Zambou NF Fonteh AF, Pérez-Chabela M (2015). Aquaculture in Cameroon and potential of lactic acid bacteria to be used as diseases controlling agents. A Review. NACAMEH 9(1):1-18

Kaminski AM, Kruijssen F, Cole SM, Beveridge MCM, Dawson C, Mohan CV, Suri S, Karim M, Chen OL, Phillips MJ, Downing W, Weirowski F, Genschick S, Tran N, Rogers W, Little DC (2020). A review of inclusive business models and their application in aquaculture development. Reviews in Aquaculture 12(3):1881-1902

MacDonald JM, Korb P, Hoppe R (2007). Experience Counts : Farm Business Survival in the U.S. Amber Waves 5(2):10-15.

Ministry of Agriculture and Rural Development, South West Region (MINADER) (2013). Annual Report for the Ministry of Agriculture and Rural Development, South West Region, Meme Divisional Delegate P 53.

Mueller V, Thurlow J, Rosenbach G, Masias I (2019). Africa's rural youth in the global context. In Mueller V, and Thurlow J (Eds.) Youth and jobs in rural Africa: Beyond stylized facts. Chapter 1: 1-24. New York, NY: International Food Policy Research Institute (IFPRI) and Oxford University Press P 323.

Nadarajah S, Flaaten O (2017). Global aquaculture growth and institutional quality. Marine Policy 84:142-151.

Ngeywo J, Basweti E, Shitandi A (2015). Influence of Gender, Age, Marital Status and Farm Size on Coffee Production: A Case of Kisii County, Kenya. Asian Journal of Agricultural Extension, Economics and Sociology 5(3):117-125.

Ottinger M, Clauss K, Kuenzer C (2018). Opportunities and Challenges for the Estimation of Aquaculture Production Based on Earth Observation Data. Remote sensing of Environment 10:1076.

Ozigbo E, Anyadike C, Adegbite O Kolawole P (2014). Review of Aquaculture Production and Management in Nigeria. American Journal of Experimental Agriculture 4(10):1137-1151.

Roumasset J (2003). Rural Institutions, Agricultural Development, and Pro-Poor Economic Growth. Asian Journal of Agriculture and Development 1(1):61-82.

Rwelamira JK (1999). Effect of Socio-economic and Gender Issues on sustainable resource management. In: Kaumbutho PG, Simalenga TE (eds). Conservation Tillage with Animal Traction: A resource book of Animal Traction Network for Eastern and Southern Africa: ATNESA publications, Harare, Zimbabwe P 173.

Skirbekk V (2003). Age and Individual Productivity: A Literature Survey. Mpidr Working Paper pp. 28-38.

Sujatha KA, Anith J, Senthilkumaar P (2013). Total protein and lipid content in edible tissues of fishes from Kasimodu fish landing centre, Chennai, Tamilnadu. European Journal of Experimental Biology 3(5): 252-257.

Toguyeni A (2004). Tilapia production and its global impacts in central African countries. In: 6th International Symposium on Tilapia in Aquaculture. BFAR and ATA, Manila P 808.
Vélez EJ, Lutfi E, Azizi S, Perelló M, Salmerón C, Riera-Codina M, Ibarz A, Fernández-Borràs J, Blasco J, Capilla E (2017). Understanding fish muscle growth regulation to optimize aquaculture production. Aquaculture 467:28-40.
World food program (WFP) (2016). Type of Malnutrition www.wfp.org/hunger/malnutrition/types
Zakaria, H. (2017). The drivers of women farmers' participation in cash crop production: the case of women smallholder farmers in Northern Ghana. The Journal of Agricultural Education and Extension 23(2): 141-158
Zhou X (2017). An overview of recently published global aquaculture statistics. FAO Aquaculture Newsletter 56:6-8.