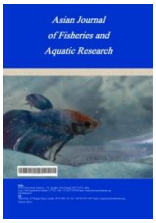

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Characteristics and Structure of Freshwater Fish Farmers in Ghana: A Socio-economic Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This Study was undertaken in all the ten (10) administrative regions of Ghana with the aim of examining freshwater fish farmers' characteristics and structure. Socio-economic status showing characteristics and structure are relevant and contribute towards the designing of more realistic people centered rural development programs in relation to high returns on projects and programmes.

Data was collected in 2016 using a semi-structured questionnaire, loaded unto an online data collection software (*Kobo Toolbox*) and configured on a tablet.

Results showed that the industry is male dominated. A greater percentage of the male and female respondents were in their productive years (36-65 years), highly educated (tertiary level) and married. The main occupation of most fish farmers is agriculture with an average household size of 6.

A higher percentage of both sexes had none of their children involved in aquaculture. Average fish farming experience for males and females was 6 and 5 years respectively with a range of 1 to 10 years. Main production systems is pond followed by cages and the key cultured species is tilapia (*Oriochromis Niloticus*) with the others being catfish (*Clarias gariepinus*), heterotis (*Heterotis*

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niloticus) and snakehead (*Barachana obscurus*). A greater percentage of the respondents were involved in monoculture system. Both male and female fish farmers practiced mainly semi-intensive system for pond culture followed by intensive system of farming mainly for cage culture. The number of production cycle is mainly 1 followed by 2 in a year. Sampled farmers practiced semi-intensive, intensive and extensive systems of farming and the three main land ownership categories accessed by fish farmers were outright purchased, freehold and leasehold.
Main source of funding for fish farming is self for both sexes. Both accessed their fingerlings mainly from the private sector. A greater percentage procure fish feed from local source while the three main sources of water for fish farming were rivers, streams and boreholes.

Keywords: Characteristics; structure; freshwater; aquaculture; fish farmers; Ghana.

1. BACKGROUND

Fish in Ghana are obtained from three main sources: capture, culture-based and aquaculture. Capture fisheries involves fish harvesting from marine (the ocean); brackish water (lagoons); Freshwater (Riverine: such as Oti, Pra, Black and White Volta; and lacustrine: Including Lakes Volta and Bosomtwi) sources. Culture-based fisheries is practiced in reservoirs, dams and dug-outs mainly in the three northern regions of Ghana whereas aquaculture is practiced in both fresh and marine water sources [1].

The fisheries sector plays a crucial role in the economy of Ghana. It accounts for 1.0% and 5.1% of Gross Domestic Product (GDP) and Agriculture GDP respectively. The gross domestic product for fish (capture and culture) is valued at GHS2, 808 million at current market prices [2]. Fisheries sector is the main source of fish food and employs about 10% of the populace for their livelihoods.

In Ghana, fish contributes significantly to nutritional food security by providing the bulk (over 60%) of the country's low-cost but high quality protein requirements as well as essential minerals, vitamins and fats. The per capita fish consumption in Ghana, over the last decade was within the range of 20-25 kg much higher than that of the average of 14 kg for the ECOWAS zone [1].

The total aquaculture production increased from 10,200 mt (2010) to 76,620 mt (2018) representing 651.2% increase. Gross Domestic Product of aquaculture increased from 0.07% in 2013 to 0.13% in 2017. This is as a result of high fish production from private cage farms within the country. The sector recorded about 2,300 fish farm establishment [1]. Freshwater fish farming in Ghana plays a vital role in the socio-economic development of the country.

FAO [3] indicated that socio-economic status are important in the provision of visions about rural realities. These statuses contributes onwards the designing of more realistic people centered rural development programs in relation to high returns on projects and programmes. According to Pandey and Upadhayay [4], the socio-economic conditions of small-scale fish farmers is a requirement for the design and successful implementation of Government pogrammes hence this study.

Demography (e.g. gender, age of farmer, educational level, experience among others), production characteristics, income and expenditure pattern of people influence strongly their responses to changes and participation in development programs. Also, lack of reliable information on the socio-economic conditions of target groups and regular update of information is a severe weakness in the successful implementation of the developmental schemes. Some studies have been undertaken at different levels on socio-economic surveys by various researchers in the fisheries sector [5,4]. This include profitability analysis of all-male tilapia farming in Sekyere South and Bosomtwi District of Ashanti region [6], Economics of aquaculture production: a case study of pond and pen culture in southern Ghana [7], and Frontier analysis of aquaculture farms in the Southern sector of Ghana [8]. The study therefore examined the characteristics and structure by undertaking a socio-economic analysis of freshwater fish farming in Ghana in terms of demographics, social characteristics, occupational standing, and economic standing, among others.

2. REVIEW

A study conducted by Boateng et al. [6] on the profitability analysis of all-male tilapia farming in the Ashanti region of Ghana concluded that the age of the fish farmers sampled for their study ranged from 20 to more than 65 years. The all-

male tilapia farmers whose ages fall between 36 and 50 years constituted the majority. On the whole, 91.3% of the farmers fall into the economically active population bracket group of 20 to 65 years. This is consistent with observations made by Addae-Mensah [9] that economically active age group in Ghana is between 14 and 66 years. This also collaborate the finding of [10,11] who observed that fish farming in Ghana is clearly for both the older and the middle-aged farmers with very few young people venturing into the fish farming business.

A research undertaken by Onumah and Acquah [8] revealed that older farmers are technically less efficient than the younger ones who are progressive and eager to implement new production methods. Hence, if aquaculture is to survive in Ghana, there is a need to put in place measures that will attract the youth into aquaculture.

According to Boateng et al. [6], male fish farmer constituted 65% as compared to the female farmers that represent 35%. This indicates the dominance of men in fish farming. This agrees favourably with [12,7], who attributed the low number of female ownership of farms to the fact that traditionally men are deemed the head of the household unit in Ghana and farms owned and run by a family are likely to be in the name of the head of the family. Onumah and Acquah [8] reported a positive relationship between households with a high level of formal education and technical efficiency of fish farmers. This implies that level of education of fish farmers is very important to the development of the fish farming industry and also can help in designing appropriate training programs tailored to their levels. It was also evident that most of the farmers (72.5%) were part time all-male tilapia farmers whilst minority (27.5%) was engaged full time.

3. METHODOLOGY

3.1 Survey Design and Data Collection

The study employed a well-structured questionnaire, loaded unto an online data collection software (*Kobo Toolbox*) and configured on a tablet for data collection. Interviews were conducted to obtain primary data (qualitative and quantitative) from fish farmers. The questionnaire was designed to capture information on the general demographics, technical operations, and challenges of the industry. Data was collected from June to November, 2016.

A purposive sampling was employed in the selection of the grow-outs fish farmers. In selecting the number of grow-out fish farmers in the regions, a list of fish farmers (population) was obtained from the Inland Fisheries Management Division of the Fisheries Commission, Ghana, out of which the sample size was calculated at a 10% margin of error and 90% confidence level. This list of fish farmers was compiled with the support of FAO of the United Nations. Where the fish farm is not functional, a back-up was depended upon. The back-up involved choosing other farmers existing in the region at random. The sample size took into consideration available female grow-out farmers in the regions and communities. A random sampling technique was employed in the selection of respondents from all the ten (10) regions.

Table 1. Regional distribution

	All	Male	Female
Ashanti	54 (11.0%)	53 (11.5%)	1 (3.0%)
Brong Ahafo	58 (11.8%)	55 (12.0%)	3 (9.1%)
Central	52 (10.5%)	49 (10.7%)	3 (9.1%)
Eastern	101 (20.5%)	98 (21.3%)	3 (9.1%)
Greater Accra	57 (11.6%)	53 (11.5%)	4 (12.1%)
Northern	18 (3.7%)	16 (3.5%)	2 (6.1%)
Upper East	24 (4.9%)	19 (4.1%)	5 (15.2%)
Upper West	13 (2.8%)	9 (2.0%)	4 (12.1%)
Volta	53 (10.8%)	49 (10.7%)	4 (12.1%)
Western	63 (12.8%)	59 (12.8%)	4 (12.1%)
Total	493 (100.0%)	460 (100.0%)	33 (100.0%)

3.2 Sample Size

A total of five hundred and fifty (550) grow-out fish farmers were randomly selected across the country for questionnaire administration out of which 493 were analysed. The sample per region considered: the concentration of aquaculture operators (grow-out); total number of fish farmers; and covered all four (4) culturing facilities (cage, tank, earthen pond and dam/reservoir/dug-out). Table 1 highlights regional distribution of sample size of respondents based on aquaculture facilities available.

3.3 Data Analysis

Data collected was analysed using SPSS (v.20) and Microsoft excel. Results are presented as figures, tables, minimum, maximum and standard deviation. Student t-test was employed to test for significant difference between some variables by gender.

4. RESULTS

4.1 Demographic Characteristics

Gender: Fig. 1 summarizes fish farmers by gender. Results shows that majority of the fish farmers sampled were males representing 93.3% compared to the females that formed 6.7%. This showed that the industry is male dominated.

Age: Age is believed to influence decision making of fish farmers. The age of fish farmers is described in Table 2. It ranged from 16 to 88 years with average age of 49 years and a modal figure of 42 years (28%). The age of the female fish farmers also ranged between 33 to 74 years with an average age of 52 years. Furthermore, that of males is between 16 to 88 years with an average age of 49 years. There is no significant differences between the ages of male and female respondents with a mean difference of 3 [*df* = 477, Prob. = 0.810 (P>10%)].

Results pointed out that 16.4% of the sampled grow-out fish farmers is within the youth category (16-35%). This implies that a greater percentage of those into fish farming in Ghana are outside the youth category which can be classified as active labour category (Table 2).

Table 2. Age range of respondents

	All	Male	Female
16-25	5 (1.0%)	5 (1.1%)	0 (0.0%)
26-35	74 (15.4%)	71 (15.9/%)	3 (9.1%)
36-45	126 (26.3%)	116 (26.0%)	10 (30.3%)
46-55	131 (27.3%)	122 (27.4%)	9 (27.3%)
56-65	101 (21.1%)	96 (21.5%)	5 (15.2%)
66-75	34 (7.1%)	28 (6.3%)	6 (18.2%)
> 75	8 (1.7%)	8 (1.8%)	0 (0.0%)
Total	479 (100.0)	446 (100.0%)	33 (100.0%)

Educational level of respondents: In terms of changing attitude, education plays a significant role. Table 3 depicts the level of education of respondents. A greater percent of the respondents are well educated and had attained tertiary level of education followed by Middle/Junior school levels hence can read and write. Very few of them are illiterate. The results conclude that most respondents sampled for this study have attained high level of education.

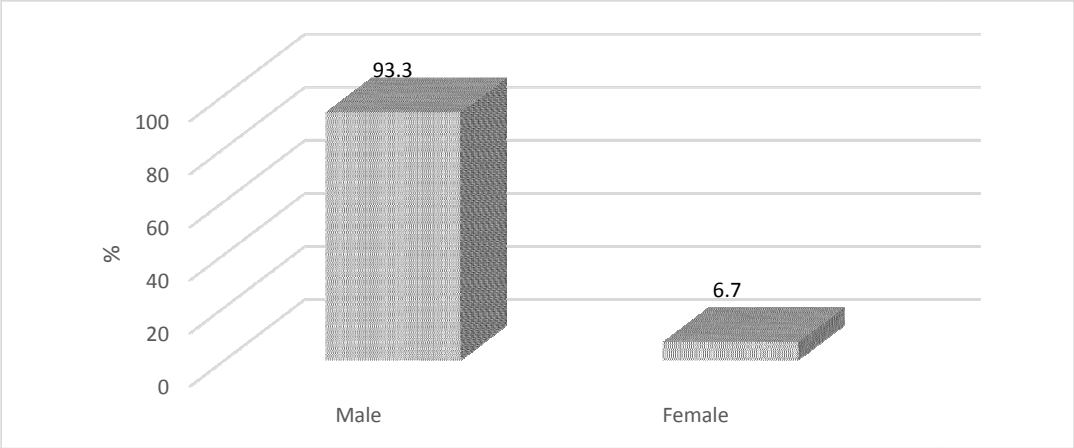

Fig. 1. Gender of sampled respondents

Table 3. Educational levels of respondents

	All	Male	Female
None	15 (3.0%)	12 (2.6%)	3 (9.1%)
Primary	30 (6.1%)	27 (5.9%)	3 (9.1%)
Middle/Junior High School	146 (29.6%)	137 (29.8%)	9 (27.3%)
Secondary/Senior High School	60 (12.2%)	58 (12.6%)	2 (6.1%)
Tertiary	225 (45.6%)	210 (45.7%)	15 (45.5%)
Others	10 (2.0%)	9 (2.0%)	1 (3.0%)
No respond	7 (1.4%)	7 (1.5%)	-
Total	493 (100.0%)	460 (100.0%)	33 (100.0%)

The other levels of education included informal education, certificate in agriculture, Islam and commercial education, technical education, and Doctoral degree (PhD). Two of the respondents (others) who were males had attained a PhD level which is encouraging (Table 3). This implies that about half of the sampled respondents are highly educated.

Marital status: Table 4 summarized marital status of the sampled respondents. Both sexes of respondents report of high percent of married fish farmers.

Main occupation: Male fish farmers sampled were involved in multiple businesses as sources of livelihood. Results showed that the main occupation of most of the male respondents are: agriculture (30%) including tree crop and annual crop farming followed by those into fish farming (20%). The others included: professionals (accountants, agricultural extensionist, Information and Communication Technologists, administrators, agronomists, agriculturists and bankers), businessmen and women, artisans (carpenters, electricians, fabricators, mechanics, and masons), Ministers of God, educationist (teachers, headmaster, lectures), security services (soldiers and police officers) health workers, government workers (public and civil servants), transport sector (transport owners and drivers), mining, trading, animal and poultry farmer, engineers, traditionalist, artist, input dealers, cold store operators, fishers and hospitality industry. There were also retirees and students who were involved in fish farming among others.

Also, most of the female respondents (24.2%) were into agriculture followed by petty trading (12.1%). The rest included government workers (public and civil servants), educationist, fish farmers, fishers, clearing agent, construction workers, health professionals and businesspersons as well as housewives.

Household size: The minimum and maximum household size of female grow-out fish farmers sampled ranged from 2 to 14 with an average of 6 people. Also, the household size of male fish farmers sampled for this study was between 1 to 25 with an average household size of 6. In all, the household size of the sampled respondents ranged from 1 to 25 with an average size of about 6 people.

Children involved in aquaculture: Results showed that the number of male children involved in aquaculture, for the female respondents ranged from 0 to 4 people while female children ranged from 0 to 3. Also, the analysis showed that the number of female and male children of the male sampled respondents, ranged from 0 to 10 and 0 to 8 respectively.

Table 4. Marital status of fish farmers

	All	Male	Female
Married	431 (87.4%)	406 (88.3%)	25 (75.8%)
Single	41 (8.3%)	41 (8.9%)	0 (0.0%)
Widowed	10 (2.0%)	3 (0.7%)	7 (21.2%)
Divorced	4 (0.8%)	3 (0.7%)	1 (3.0%)
Separated	1 (0.2%)	1 (0.2%)	0 (0.0%)
No response	6 (1.2%)	6 (1.3%)	0 (0.0%)
Total	493 (100.0%)	460 (100.0%)	33 (100.0%)

Table 5. Percent of male and female children into aquaculture

Gender	No. of children	% Male children	% Female children
Female	0	37.0	58.3
	1	25.9	25.0
	2	22.2	12.5
	3	11.1	4.2
	4	3.7	0.0
Male	0	59.6	68.2
	1	18.9	15.7
	2	12.1	10.5
	3	5.1	1.7
	4	2.3	1.9
	5	0.5	0.8
	6	0.8	0.3
	7	0.0	0.3
	8	0.5	0.6
	10	0.3	0.0

The results further pointed out from Table 5 that majority of the male and female grow-out farmers sampled had none of their male and female children involved in aquaculture. Table 5 showed that 37% and 58% of the female grow-out farmers indicated that none of their male and female children were involved in aquaculture as against 59.6% and 68.2% respectively of the male grow-out farmers Results highlighted that there were higher percent of both sexes who had only 1 and 2 male and female children respectively involved in aquaculture.

The results conclude that in all (493), 58.2% and 67.6% of the sampled respondents reported that their male and female children respectively were not involved in their aquaculture activities.

Experience in fish farming: Fig. 2 displays the experiences of fish farmers. The results showed that majority of both sexes had experiences ranging from 1 to 5 years followed by 6 to 10 years. Furthermore, 6.1% of the male fish farmers had experience of 11 to 20 years while the rest (3.9%) had been operating from 21 to 50 years. The years of experience for the females ranged from 1 to 12 years with an average of 5 years while their male counterparts operated between 1 to 49 years with an average experience of 6 years. T-test analysis showed that there was no significant difference between the experience of males and female in fish farming [*df*= 489; Prob. = 12.1 (P>10%)] even though the average years of experience of male (6.43 ±5.9 years) is greater than that of the females (4.82 ±2.9 years).

Most of the females interviewed were involved in fish farming for a period of 2 years (21.2%) followed by 5 years (18.2%). The modal experience in fish farming for the males is 2 years (14.6%) followed by 3 years (14.2%).

Production cycle: Fig. 3 summarizes the major holding facilities of respondents. It can be deduced from this study that fish is mainly cultured in ponds followed by cages. This applies to both sexes.

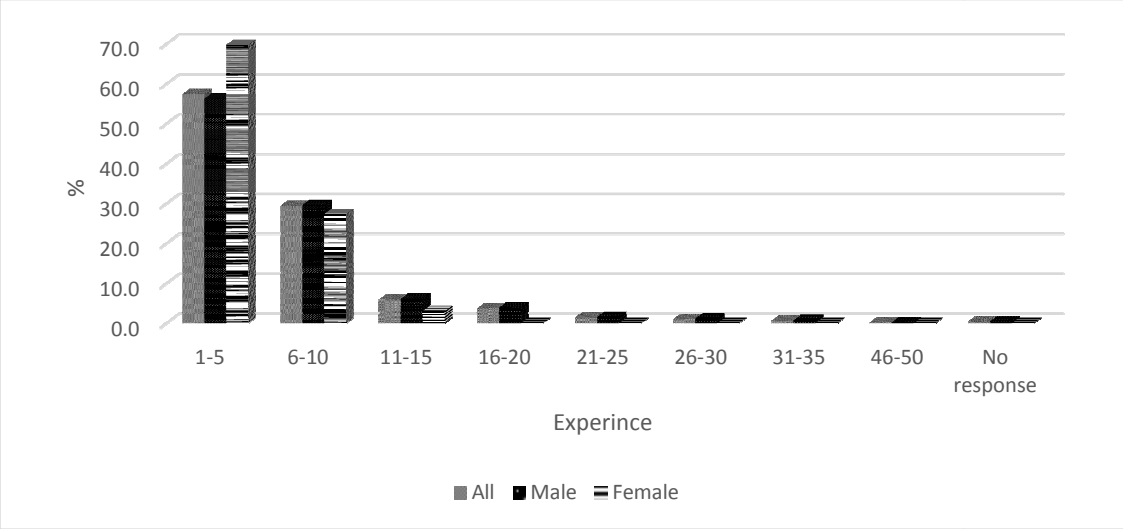

Fig. 2. Fish farmers' experience

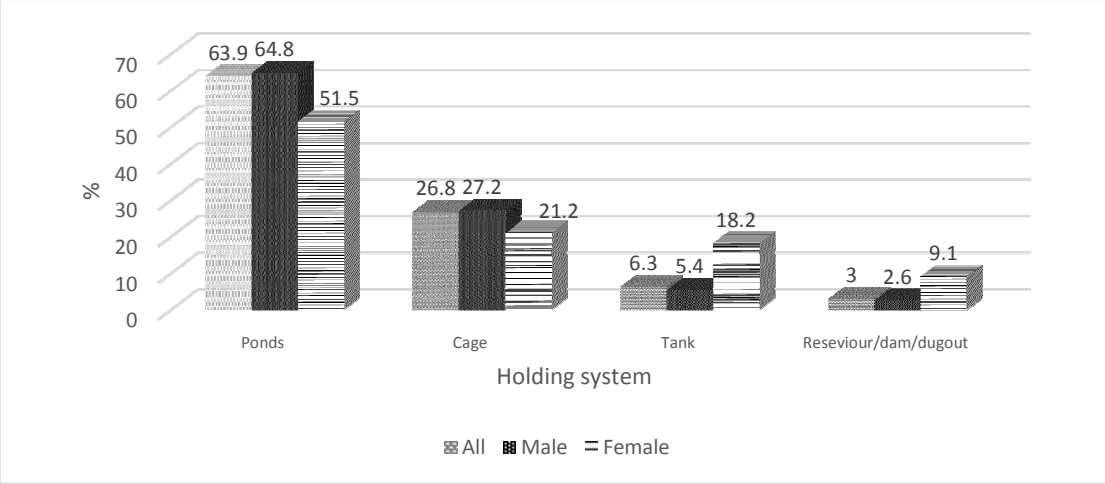

Fig. 3. Major holding facilities

Cultured species: Farmers produced various species. The three (3) main fish species cultured by both sexes were Nile tilapia (*Oriochromis Niloticus*), catfish (*Clarias gariepinus*) and heterosis (*Heterosis niloticus*) with tilapia as the dominant species. Results showed that a good number of respondents cultured mixed species (Table 6). The other species which were not deliberately culture include snakehead (*Barachana obscurus*).

Type of culture: The study discovered that the types of culture in fish farming were poly and mono. A farmer may operate the two depending on the number of ponds and tanks available to him/her except cage fish farming which employs monoculture for tilapia farming. A farmer may apply both or either of them in fish farming for pond culture. A greater percentage of the respondents from this study (64.9%) were into only monoculture (only tilapia and only catfish with only tilapia being the dominant) while 20.5% applied only polyculture (mainly for tilapia and catfish). Results suggested that in terms of gender disaggregation, 72.7% of the females and 64.3% of males were involved in only monoculture respectively while 27.3% females and 20% males were into only polyculture correspondingly.

Production system of culture: Several systems exist in Ghana. They are made up of intensive, semi-intensive and extensive systems. The intensive systems occur mainly with cage culture. Fig. 4 summarizes the various production systems employed in fish farming by the sampled respondents. In all, most respondents (53.8%) pursued a semi-intensive system of farming (peculiar to pond fish farmers) followed by intensive system (38.7%). This could be so due to high cost of input such as feed in the production processes. Semi intensive system is also ranked as first for both sexes followed by intensive systems of farming.

Table 6. Species cultured by respondents

	All	Male	Female
Nile tilapia only	224 (45.4%)	206 (44.8%)	18 (54.5%)
Catfish only	71 (14.4%)	67 (14.6%)	4 (12.1%)
Nile tilapia & catfish	167 (33.9%)	158 (34.3%)	9 (27.3%)
Nile tilapia catfish & others	2 (0.4%)	2 (0.4%)	0 (0.0%)
Nile tilapia & heterotis	1 (0.2%)	1 (0.2%)	0 (0.0%)
Nile tilapia heterotis & catfish	21 (4.3%)	19 (4.1%)	2 (6.1%)
Heterotis & catfish	1 (0.2%)	1 (0.2%)	0 (0.0%)
Nile tilapia heterotis catfish & others	1 (0.2%)	1 (0.2%)	0 (0.0%)
Nile tilapia & others	2 (0.4%)	2 (0.4%)	0 (0.0%)
No response	3 (0.6%)	3 (0.7%)	0 (0.0%)
Total	493 (100.0%)	460 (100.0%)	33 (100.0%)

Some farmers depend on natural productivity of the pond (extensive system) while others use by-products from agriculture and waste from homes. The differences in percentage for females' undertaken intensive and semi-intensive systems of aquaculture is not statistically significantly different [Pearson Chi-Square value = 2.363, *df* = 3, Prob = 0.501 (P>10%)].

The study highlights the number of production cycle employed by the fish farmers (Fig. 5). Results pointed to the fact in this study that, majority of the respondents (65.1%) produced their fish once in a year stocking at a maximum of 10 g. Furthermore, there were also those (tilapia fish farmers mainly from Brong Ahafo region) who cultured fish twice or thrice in a year. It implies that such fish farmers stock at higher stocking size (e.g. 50-80 g) to reduce the period of fish farming. Comparative analysis showed a 10% level of significance of the number of production cycle between male and female fish farmers [*df* = 477; Prob. = 0.06 (P<10%)].

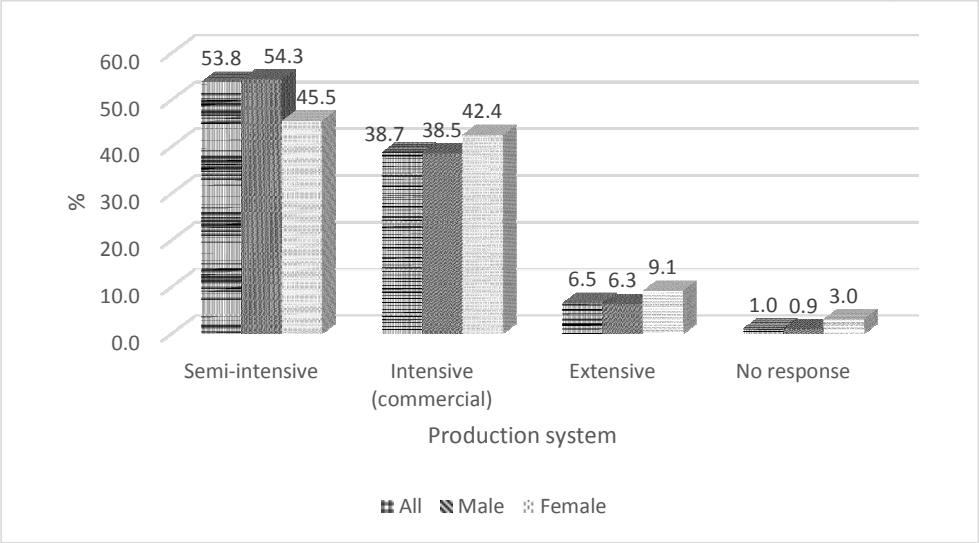

Fig. 4. Production system of respondents

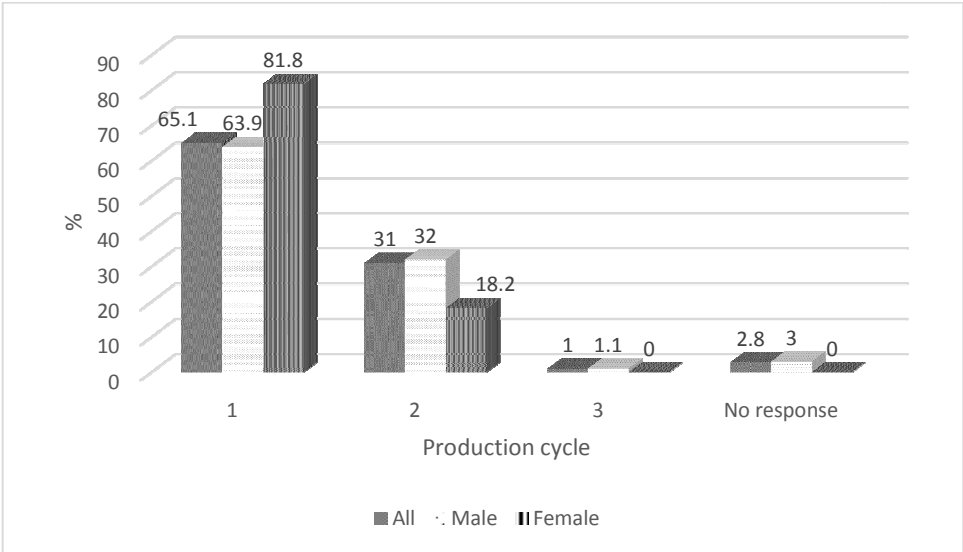

Fig. 5. Number of production cycle

Number of operational pond/cages/dams and dugouts: The number of operational ponds employed in fish farming ranged from 1 to 28 with an average of 4 ponds while that of cages ranged between 1 to 607 pieces with an average of 23. Commercial farmers build more cages for fish farming purposes. The study further revealed that number of operational tanks ranged between 1 to 20 with an average of 4 (Table 7).

Result highlights the fact that both female and male fish farmers sampled for this study employed any of the holding facilities. Female had fewer holding facilities than their male counterparts. The total number of ponds held by females ranged between 1 to 5 with an average number of about 3. Also, the number of tanks employed by the female aquaculturist in fish farming ranged from 1 to 2 with an average of 1 tank. The study showed that some women owned between 1 to 64 cages for tilapia farming with an average of 13 cages.

The result further displayed that some male fish farmers operated between 1 to 28 earthen ponds and 1 to 20 tanks. Those who undertake cage culture do so by using between 1 to 607 cages for tilapia farming (Table 7).

The study revealed that in all, 36.1% of 302 respondents reported of owning only one (1) pond for aquaculture operation followed by 22.2% who possessed 2 ponds. In all, 81.1% of the total fish farmers operated 1 to 4 ponds of different sizes. The rest fell between 5 to 28 ponds. There were equally high percentage of male (35.8%) and female (41.2%) operating only one (1) pond while 22.1% and 23.5% respectively operated 2 ponds. The study additional discovered that 70.2% of male fish farmers operated between 1 to 3 ponds while 64.7% of the females also operated 1 to 2 ponds.

Furthermore, 55.4% of 130 respondents who employed cages in fish farming had between 1 to 6 cages while the rest is spread between 7 to 607 cages. Results pointed out that 28.6% of females owned 1 cage with equal percentages (14.3%) in possession of 2, 4, 7, 12 and 64 cages respectively. A little more than half of the men (55.3%) owned between 1 to 6 cages with others spread out.

Land ownership: Cage culture activities required mainly the leasing of portions of the Volta lake for fish farming activities while land is purchased, freehold leased and/or rented for infrastructure development. Fish farmers into pond culture can undertake any of the listed land ownership methods for fish farming (Table 8).

The overall analysis of the ownership of land suggested that the highest percentage of respondents (37.5%) purchased outright the land used for fish farming followed by the freehold users (28.8%). Very few (6.3%) rent land for use in fish farming. A farmer may have more than one piece of land and ownership status may differ for each. There were equally higher percentages of male (36.7%) and female (48.5%) fish farmers who purchase land outright for fish farming followed by freehold and then leasehold (Table 8).

Table 7. Operation holding facilities

		N	Min	Max	Mean	Std. Dev
All	Number of operational ponds	302	1	28	2.97	2.766
	Number of active cages	130	1	607	23.33	70.068
	Number of tanks	31	1	20	3.9	4.346
	Number of reserviours/dams/dugouts	15	1	13	3.07	3.555
Female	Number of operational ponds	17	1	4	2.12	1.166
	Number of active cages	7	1	64	13	22.833
	Number of tanks	6	1	2	1.33	0.516
	Number of reserviours/dams/dugouts	3	1	13	6	6.245
Male	Number of operational ponds	285	1	28	3.02	2.827
	Number of active cages	123	1	607	23.92	71.827
	Number of tanks	25	1	20	4.52	4.638
	Number of reserviours/dams/dugouts	12	1	9	2.33	2.462

Table 8. Land ownership

	All	Male	Female
Outright purchase	185 (37.5%)	169 (36.7%)	16 (48.5%)
Freehold	142 (28.8%)	132 (28.7%)	10 (30.3%)
Leasehold	101 (20.5%)	96 (20.9%)	5 (15.2%)
Rent	31 (6.3%)	31 (6.7%)	0 (0.0%)
Leasehold & rent	3 (0.6%)	2 (0.4%)	1 (3.0%)
Outright, purchased & freehold	6 (1.2%)	6 (1.3%)	0 (0.0%)
Sharing	5 (1.0%)	4 (0.9%)	1 (3.0%)
Outright, purchased & leasehold	4 (0.8%)	4 (0.9%)	0 (0.0%)
Rent & freehold	4 (0.8%)	4 (0.9%)	0 (0.0%)
Leasehold & sharing	1 (0.2%)	1 (0.2%)	0 (0.0%)
No response	11 (2.2%)	11 (2.4%)	0 (0.0%)
Total	493 (00.0%)	460 (00.0%)	33 (100.0%)

4.2 Economic Standings

Main source of income: The main sources of income of the total respondents included crop farming (annual and tree crop), working at the government sector (public and civil service), fish farming, and animal rearing among others.

Majority of the females (30.3%) gained most of their income from crop farming followed by those from the public and civil service (18.2%) with the least from fish farming (3.0%) and fishing (3.0%). There were also some women (15.2%) who obtained income from petty trading.

Also, most men (23.3%) gained their main income from crop farming followed by fish farming (18.7%). In addition, 18.5% of men obtained their main source of income from the public and civil services. The others had theirs from other sources. This implied that fish farming is not the main income sources for the sampled fish farmers, it is the second and third income sources for males and females fish farmers respectively.

Source of funding: The main source of funding for fish farming activities (in all) was self-financing (85.6%) followed by the formal sector financing (commercial and rural banks) (7.3%). This applies to both sexes (Table 9).

4.3 Production

Sources of inputs: Fish farms in their bid to satisfy demand of fingerlings, purchased fingerlings from private hatcheries, government hatcheries, fellow farmers and/or buy or gather from the wild and their own farms. The results showed that a little above half (55.4%) of the fish farmers accessed fingerlings from the private hatchery (Table 10) due to its large number and spread compared to the public hatcheries, followed by about a quarter who procured from government hatcheries. Public hatcheries sold their fingerlings at subsidized price.

Out of 98 hatcheries available in Ghana, 94 are privately owned. There are 4 government hatcheries with the forth currently under construction. Private hatchery supply over 80% of fingerlings demanded by fish farms. The species are mainly from desirable sources and of good quality.

Table 9. Financing sources of fish farming (Multiple responses)

	All	Male	Female
Self	422 (85.6%)	395 (85.9%)	27 (81.8%)
Family	34 (6.9%)	32 (7.0%)	2 (6.1%)
Formal	36 (7.3%)	34 (7.4%)	2 (6.1%)
Friends	19 (3.9%)	19 (4.1%)	0 (0.0%)
Lenders	26 (5.3%)	24 (5.2%)	2 (6.1%)
NGOs	15 (3.0%)	12 (2.6%)	3 (9.1%)
Others	26 (5.3%)	22 (4.8%)	4 (12.1%)

Table 10. Main sources of fingerlings

	All	Male	Female
Private hatchery	273 (55.4%)	257 (55.9%)	16 (48.5%)
Government hatchery	115 (23.3%)	105 (22.8%)	10 (30.3%)
Own farm	58 (11.8%)	54 (11.7%)	4 (12.1%)
Fellow farmer	20 (4.1%)	19 (4.1%)	1 (3.0%)
Wild	19 (3.9%)	17 (3.7%)	2 (6.1%)
No response	8 (1.6%)	8 (1.7%)	0 (0.0%)
Total	493 (100.0%)	460 (100.0%)	33 (100.0%)

Table 11. Source of feed

	All	Male	Female
Locally produced	205 (41.6%)	187 (40.7%)	18 (54.5%)
imported	71 (14.4%)	67 (14.6%)	4 (12.1%)
Self-prepared	42 (8.5%)	38 (8.3%)	4 (12.1%)
Imported & locally produced	78 (15.8%)	74 (16.1%)	4 (12.1%)
Locally produced & self-prepared	56 (11.4%)	54 (11.7%)	2 (6.1%)
Imported & self-prepared	26 (5.3%)	25 (5.4%)	1 (3.0%)
Imported, locally produced & self-prepared	3 (0.6%)	3 (0.7%)	0 (0.0%)
No responds	12 (2.4%)	12 (2.6%)	0 (0.0%)
Total	493 (100.0%)	406 (100.0%)	33 (100.0%)

Fish farmers acquired feed from three (3) main sources such as locally produced, imported and self-prepared. In all, a greater percentage of respondents (41.6%) procured only locally produced fish feed for their farms due to high price of imported feed and low quality of self-prepared feed (Table 11).

The fish feed producer companies include Raannan Fish Feed West African Ltd, Beacon Hill Fish Feed Ltd, and Huawei Fish Feed Limited. Both sexes accessed feed mostly from locally produced sources. A relatively smaller percentage of respondents in relation to those who import and buy from local sources prepared feed on their own to feed their stocks. It was revealed from the study that 15.8% of the sampled respondents either import or procured locally produced feed to feed their fish (Table 11). Others purchased their feed from a mix of the three (3) sources.

Sources of water: Results indicated that fish farmers' accessed multiple sources of water in fish farming. This includes rivers, streams, boreholes among others. Most males used a combination of rivers and streams (44.6%) followed by boreholes, wells and underground water (28%) for fish farming. Also, a greater percentage of the females accessed water from borehole, well and underground water (42.4%) followed by rivers and streams sources (21.2%). The rest used a combination of two or more water sources. Cage farmers mostly undertake fish farming on the Lake Volta while a few set up the cages in the dams and reserviours.

Table 12 showed that in all, 58.2% and 58.0% of the fish farmers sampled accessed water from only river and only stream sources. Pipe borne water was the least source of water (3.5%) used. Results further point out that equal percentage of the females (58.6%) which formed the majority of

Table 12. Sources of water

	All*	Male*	Female*
River	267 (58.2%)	258 (60.0%)	9 (31.0%)
Stream	266 (58.0%)	257 (59.8%)	9 (31.0%)
Borehole	213 (46.4%)	196 (45.6%)	17 (58.6%)
Well	212 (46.2%)	195 (45.3%)	17 (58.6%)
Underground water	211 (46.0%)	194 (45.1%)	17 (58.6%)
Rain water	45 (9.8%)	40 (17.2%)	5 (17.2%)
Pipe borne	16 (3.5%)	11 (2.6%)	5 (17.2%)

** Multiple responses*

the female respondents accessed water from only borehole, well and underground sources while their male counterparts accessed water from mainly only rivers (60.0%), followed by only streams (59.8%).

5. DISCUSSION

The freshwater aquaculture sector in Ghana is dominated by males who formed 93.3% of the total sampled size with average age of 49 years respondents. Capture fisheries and aquaculture have often been regarded male responsibilities [13,14]. The aquaculture sector is often considered a male domain because of the high levels of investments and nature of work. Women's role and participation has often been ignored partly due to socio-cultural issues against them [15]. Male dominance could be attributed to link to the laborious nature of the fish farming including pond preparation, input application among others. This is also in agreement with [16,7] who attributed the low number of female ownership of farms to the fact that traditionally men are deemed to be the head of the household unit in Ghana and farms owned and run by a family are likely to be in the name of the head of the family.

The age of the fish farmers sampled from this study ranged from 16 to 88 years with average age of 49 years and a modal figure of 42 years (28%). Nunoo et al. [7] revealed in their study that average age of sampled fish farmers was 48.7±12.6 SD years placing them in middle class. Furthermore, Addae-Mensah [9] indicated in his research findings that economically active age group of sampled fish farmers lay within the ages of 15-65 years. In addition, the average age of male and female respondents from this study were 52 and 49 years respectively. The age of majority of both sexes ranged between 36 to 65 years. The implication is that most of the respondents were in their active age and are productive. Also, a survey conducted by FAO revealed that very few youth go into fish farming and that the middle age undertake such activities [11]. Onumah and Acquah [8] were of the view that the youth are more efficient than the elderly since they are progressive. This therefore calls for the need to entice the youth into aquaculture.

It was also revealed from the study that a greater percentage of the fish farmers sampled (45.6%) had attained tertiary level with very few (3.0%) with no formal education. This findings deviate from the results of the study conducted by Nunoo et al. [7]. In this study, there were more well educated respondent which is encouraging. The percentage of respondents with middle school leaving certificate recorded for this study (29.6%) is about 68% less of what was reported by Nunoo et al. [7] which is 43.2%. Result further pointed out that higher percentage of both male (45.6%) and female (45.7%) respondents had also attained tertiary education and high percentage were also married (87.4%). The high educational level of females in this study contradicts the findings of Butt et al. [17] that indicated low level of literacy among female fish farmers. According to Singh [18], educational level of fish farmers has an effect on knowledge level, skill development, exposure to production technology, marketing and technology adoption. Also, Onumah and Acquah [8] suggested a positive relation between fish farmers educational level and technical efficiency. Higher educational level aid the fish farmers to easily understand, assimilate and adopt new technology and efficient input application. The few with no/ or limited education can be targeted with various training programmes to address their challenges.

The main occupation for male respondents were crop farming (30%) and fish farming (20%) while that of the females were crop farming (24.2%) and petty trading (12.1%). Diversification of occupation reduces risk when there is a failure. [10] confirms this finding.

The overall family size of sampled farmers ranged from 1 to 25 people with an average of 6 people in a household. Boateng et al. [6] revealed in their study that the distribution of household size of fish farmers ranged between 1 to 12. Aeschliman [10] indicated that a larger family size represent a cheap and affordable source of labour. Family size of male fish farmers sampled from this current study ranged between 1 to 25 with an average of 6 and that of females' ranged between 2 to 14 with also an average of 6 in a family. There are more children (for male fish farmers) engaged in aquaculture as compared to the females'. Family size can be a pool and a source of cheap labour for fish farmers and could be a source of financial support given that the family may be financially equipped.

More than 50% of both sexes have fish farming experience ranging from 1 to 5 years followed by

6 to 10 years. This implies that 86.6% of total respondents have between 1 to 10 years of experience. According to Boateng et al. [6], fish farmers who have been in the business for considerable length of time will enhance their ability to increase output. The average years of experience of female fish farmers was reported to be 5 years with a range of 1 to 12 years while males was 6 years with a range of 1 to 49 years.

Most of the females (64.3%) and males (51.5%) fish farmers operated ponds for fish farming while the species cultured were Nile tilapia *(Oriochromis Niloticus*), catfish (*Clarias gariepinus*), Heterosis spp. (*Heterosis niloticus*) and snakehead (*Barachana obscurus*). This agrees with the finding by Nunoo et al. [7]. Majority of females (72.7%) and males (64.3%) were involved in monoculture. Also, more males (54.3%) were into semi-intensive system as compared to females (45.5%). Other systems of farming included intensive and extensive system of farming. The number of production cycle for most male (63.9%) and female (81.8%) fish farmers is 1. Results further showed that in all, a high percentage (31.0%) cultivate fish twice in a year.

In all, number of operational ponds for fish culture ranged between 1 to 28, tanks ranged between 1 to 20 while cages ranged between 1 to 607. Average quantity of ponds, tanks and cages for female grow-out farmers were 2, 1 and 13 respectively and that of the males were 3, 5 and 25 respectively. Most males (35.8%) and females (41.2%) operated only 1 pond. Also, 60% of males and 66.7% of females operated only 1 tank. Additionally, 28.6% of females owned only 1 cage whiles 55.3% of males owned a maximum of 6 cages.

From the result, most farmers sampled (37.5%) purchased outright their land for fish farming with very few renting (6.3%). This applies to both sexes. Results shows that 36.7% of male fish farmers and 48.5% females' purchased land outright. Furthermore, 28.7% of males and 30.3% of females enjoyed freehold land. The main source of funding for aquaculture activities for both sexes were self-financing followed by the formal sector (commercial and rural banks). According to Boateng et al. [6], most farmers use their own resources to finance their operations. Those with inadequate individual resources, credit is an alternative of accessing funds. A rural Bank supports a Fish Farmer Association in the Brong Ahafo region of Ghana with fish feed input.

Most males and female fish grow-out farmers accessed their major source of fingerlings from private hatcheries followed by government sources with the least source of fingerlings from the wild. FAO [19] pointed out that reliance of farmers on fish seed from the wild stocks and fellow farmers are considered unreliable sources and are of poor genetic quality and health, or are undesirable species. The study revealed that fish farmers accessed quality fish seed from certified sources due to its quality and availability. Also, a higher percentage of males (41.6%) and females (54.5%) bought feed from only local sources followed by only imported sources (male-14.6%, Female-12.1%). Very few of the fish farmers produce their own feed (8.5%) using local raw materials. The rest depended on all the three sources. The source of water for fish farming included rivers, streams, boreholes, well, underground waters among others with rivers only and streams only ranking as the first two main water sources for both sexes. Cage farmers used mostly rivers with very few cages planted in dams and reserviours.

6. CONCLUSION

The objective of the study was to examine the characteristics and structure of freshwater fish farmers in Ghana by profiling them. The study revealed male dominance in the sector and most of the respondents are in their prime years. It is encouraging to note that most fish farmers interviewed are highly educated even though there were a few who had no formal education hence the need to provide relevant training programmes targeting them.

A little above half of the sampled fish farmers (57.4%) had 1-5 years experience in fish farming followed by 29.4% who had gained 6-10 years of experience. Fish holding facilities employed by most respondents were ponds, cages, and tanks in order of rankings. The following were species cultured by the fish farmers: Nile tilapia (*Oriochromis Niloticus*), catfish (*Clarias gariepinus*), heterosis (*Heterosis niloticus*) and snakehead (*Barachana obscurus*) with tilapia as the main species cultured. Most farmers were into monoculture system while some undertook polyculture system of farming. For aquaculture to achieve its potential, those who undertake such activities should consider it as a first option in income generation. It is understood that farmers will love to diversify their risk hence most farmers from the study mainly depend on agriculture as their income sources with fish farming and others

as an additional income sources. Also, a good number of fish farmers production cycle last once in a year for especially tilapia with other farmers cropping twice and thrice in a year. Fish farmers are advised to stock fish of bigger size especially tilapia to produce it within a shorter period. Farmers practiced semi-intensive, intensive and extensive systems of farming and most of them owned their land by outright purchased followed by freehold. In such instances, a farmer may decide what to do with the land. Most respondent financed fish farming from own source, access fingerlings mainly from the private hatcheries for quality purpose even though a few still pick from the wild or from friendly fish farmers; depend on mostly locally produced fish feed due to high cost of imported feed and used mainly river water for fish farming. Fish farmers are advised not to pick fish seed from the wild and friends farmers but rather certified hatcheries that produced quality fingerlings.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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