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Sunday Brownson Akpan, Udoro Jacob Udo, Prisca Joseph Akpan

Akwa Ibom State University, Mkpat Enin
Nigeria

ANALYSIS OF THE GROSS MARGINS AND COMMERCIALIZATION OF MANURE AND FERTILIZER BASED WATERLEAF (*Talinum triangulare)* FARMERS IN NIGERIA

Purpose. *Waterleaf production is an emerging crop enterprise and is a reliable source of livelihood for many unemployed women around peri-urban centres and rural areas in the southern region of Nigeria. Its production is most hindered by low soil fertility caused by continuous cropping and increasing alternative land uses among others. In response to low soil fertility, Waterleaf farmers have resorted to the use of organic manure and or fertilizer to enrich the soil. In an attempt to develop an appropriate policy framework that would encourage sustained use of soil enhancing materials among small scale farmers, the study compared the economic performance of the organic manure-based and fertilizer based Waterleaf farmers in Uyo agricultural zone of Akwa Ibom State, Nigeria.*

Methodology / approach. *The study was conducted in the southern region of Nigeria. Waterleaf farmers were selected using random sampling and the data was obtained using a well-structured questionnaire. Inferential and descriptive statistics including multiple regression technique based on Ordinary Least Squares estimation technique were employed.*

Results. *Empirical results showed that the following socioeconomic characteristics were statistically different between Waterleaf farmers using organic manure and those utilizing fertilizer: age, education, household size, years of membership in social organization, access to extension services, farm size, and farm income. The results further revealed that organic and fertilizer based Waterleaf farmers earned income (gross margin) that averaged at ₦17835.00 and ₦18783.12 respectively, for a single production cycle and it was statistically similar. The OLS result showed that education, farm income, and gender had a significant positive impact on the gross margin of organic manure users while stem cost household size, membership in social organization, labour cost and farm credit showed a significant negative effect. Also, farmers' age, farm income, and household size showed a positive effect on the gross margin of fertilizer based farmers while education, marital status, stem cost social organization, labour cost, the quantity of Waterleaf stolen, gender and farm size showed a significant negative impact. The findings also revealed that the level of commercialization in organic manure farmers was higher and statistically different from fertilizer based farmers. Empirical results showed that farmers' age, education, farming experience, farm size, and social capital formation have a positive influence on the level of commercialization of fertilizer based farmers while gender, household size, and a household dependent ratio showed a significant negative effect. On the other hand, education, gender, farm size and extension service have positive correlations with the level of commercialization of organic farmers while household size, household dependent ratio, and marital status have a negative impact.*

Originality / scientific novelty. *The study has developed out of absolute necessity to sustain Waterleaf production as a means of livelihood for thousands of resource-poor farmers and unemployed women in the region. This is the first attempt to analyse the production performance of categories of Waterleaf farmers practising different soil management techniques in the region. The* *findings satisfied a priori expectations and reflected the extent of economic and environmental deterioration engulfing the small scale farmers in the region.*

Practical value / implications. *The study has identified policy variables that will enable policymakers to develop a sustained policy framework that would enhance the use of manure and fertilizer by small scale farmers in the region. To further enhanced sustainability of Waterleaf enterprise, it is recommended that, adult education should be encouraged and extension services, strengthen as well as planned subsidies for fertilizer and other farm inputs for Waterleaf farmers in the region.*

Key words: *Vegetable, organic manure, fertilizer, Waterleaf, commercialization, farmers, Akwa Ibom State.*

Introduction and review of literature. Agricultural production in Nigeria is dominated by small scale resource farmers (Mgbenka *et al.*, 2015; Akpan *et al.*, 2012a). Smallholder farmers constitute more than 60 % of the farming population in Nigeria (Awoke and Okorji, 2004; Akpan, 2012). One major problem faced by small scale farmers in Nigeria, especially in the densely populated region of the South-South is "land fragmentation" imposed by increasing population density and urbanization. This has resulted in increasing agricultural land-use intensification leading to the collapse of the traditional land fallowing system of cropping, increase soil depletion and low crop yield among others (Azagaku and Anzaku, 2002). Agriculture as the major source of rural population's livelihood must be practiced in a sustainable manner (Aderinoye-Abudulwahab *et al.*, 2015, and Akpan *et al.*, 2012b). Sustainable agricultural development implies meeting the demands of the present generation without compromising the power of the future generation to conform to their own needs (World Commission on Environment and Development, 1987). The struggle for food supply to catch up with the massive population growth takes a coherent and decent stage of soil fertility achieved in a sustainable way (Bot and José, 2005). As asserted by Vanlauwe *et al.*, (2014), sustained soil fertility, an ingredient of natural capital is a key to the support of the bulk of the rural population of the sub-Saharan Africa who depend on farming as a key factor in their livelihood strategy. Lal (2009) and Chianu *et al.*, (2012) noted that one of the leading components to low yields and insufficient food in most developing countries is low soil fertility. As a result, small scale farmers in developing countries who produce the bulk of food have to utilize either organic or fertilizer or both sources of soil enhancing materials to increase yield (International food policy research institute, 2011; Food and Agriculture Organization, 2013). Experts thought that soil infertility stems from the fragility and the high susceptibility of the soils to degradation. Continuous cropping without planning replenishment leads to the continuing loss of soil nutrients, hence making augmentation through the role of soil enhancing materials obvious and unavoidable (Alimi *et al.*, 2006).

One of the crop enterprises that is highly cherished and constitutes one of the major constituents of the dietary requirement of most Nigerians is the vegetable crops (Akpan and Okon, 2019). The nutritive and medicinal values of vegetable crops are overwhelming. Waterleaf (*Talinum triangulare*) is among the most popular vegetable crops produced in Nigeria. It is widely taken across many ethnic groups and is called *mmon-mmong ikong* by the *Ibibio's* and *Efik* tribes in the southern region of Nigeria (Akpan *et al.*, 2018). The demand for Waterleaf is high throughout the year and is generally cultivated by thousands of resource-poor small scale women farmers (Etim and Udoh, 2014; Udoh and Akpan, 2007). Referable to the agronomic requirement of Waterleaf production and intensified cropping system practiced by farmers, the crop production required sustained soil enhancing materials or additives. Manures being one of the widely used soil enhancing materials used by the farmers consist mostly of plant and animal wastes (Akpan and Aya, 2009). The most common manure used in Waterleaf production is poultry litter, droppings of sheep and goat as well as farmyard manure. Also, naturally occurring or synthetic chemicals containing plant nutrients known as fertilizers are other sources of soil enhancing material available to Waterleaf farmers. The extent of usage of these soil enhancing materials by Waterleaf farmers depends, among others, on the social, environmental and economic factors surrounding the farmers.

Akwa Ibom State being one of the States in the southern area of Nigeria has gone along to experience increasing soil fertility deterioration following farmers' intensive and continuous cropping for survival, increase in soil erosion coupled with poor nutrient conservative practices of most farmers, among others (Udoh *et al.*, 2011; Bassey *et al.*, 2009; and Akwa Ibom State Ministry of Agriculture 2010). Too, the threatening effect of land and water pollutions following the activities of the multi-national oil drilling companies in addition to increasing population density have further exasperate soil infertility issues in the area. Agricultural production has been relegated to the marginal lands and intensive cropping has gradually replaced the traditional shifting cultivation that is associated with a long period of land fallowing or conservation. The sustainability of such an emerging crop enterprise is hinged on a well-planned management of soil enhancing additives such as organic manure and fertilizer.

Assessment of the performance of the vegetable farmers in the south – south region of Nigeria could be answered in two ways. The first is analysing the gross margin generated in the business while the other is the evaluation of the extent of commercialization of the output produced (Aya and Akpan, 2009). As noted by Pingali (1997), in the long-run, subsistence agriculture may not be a viable activity to ensure sustainable household food security and welfare. By implication, the sustainability of organic and fertilizer based Waterleaf production in the region is rested among others on the development of a sound and appropriate policy frameworks and instrument that would ensure the achievement of an acceptable level of gross margin and output commercialization. Premised on the above assertions, the study is specifically designed to contribute useful information to policymakers in this direction.

Gross margins and profitability of vegetable farmers and its determinants. Few studies have examined issues related to the gross margins and profitability of vegetable farmers. For instance, Xaba and Masuku (2013) identified factors affecting the productivity and profitability of vegetable production in Swaziland. According to their findings, determinants of profitability of vegetable production were level of education, land under vegetable production and type of marketing agency. Also, Ndungu *et al.* (2013) analysed the profitability of organic vegetable production systems in Kiambu and Kajiado counties of Kenya. Results showed that age and number of trainings attended; availability of irrigation, target market. Output per acre, the cost of production and price per unit were found to have positive correlations with the profitability while farming experience had a negative relationship. In Nigeria, Henri-Ukoha *et al.* (2015) analysed returns from organic and inorganic manure-based vegetable farms in the Owerri municipal area of Imo State, Nigeria. Findings revealed that the net-income from inorganic farmers was greater than that of organic-based farmers. In a similar Venn, Amadou and Bruno (2015) in Senegal compared the performance of organic farming and conventional farming system. Results showed that the gross margin of organic farming was less than that of the conventional farming system. Furthermore, Ridwan *et al.* (2014) examined the determinants of gross margin of vegetable farmers in the Iwo zone by the Osun State of Agricultural Development Programme (ASDP). The result of the findings revealed that the labour cost, cost of fertilizer and cost of seed was the main determinants of the gross margin in vegetable production. Elsewhere, Fakkhong and Suwanmaneepong (2016) identified determinants of profitability of rice farming in the peri-urban region of Bangkok, Thailand. The results revealed that the factors that significantly affected the profitability of rice farming were gender, social status, number of family labour, land size and rice variety. Elsewhere, Rugube *et al.* (2019) investigated the factors affecting the profitability of smallholder vegetable farmers in the Shiselweni region. The results revealed that land size, gender and household size, had a direct relationship with the profitability of vegetable production while age, education, experience, income, and labour had a negative relationship. In another related study, Singh *et al.* (2017) studied gender contribution to the profitability of vegetable production in the rural Mmanzini region of Swaziland. The results showed that the profitability of the male cabbage producers was significantly influenced by the farm size, quantity grown, the selling price and access to market, whereas experience, the seedlings or seed costs and the selling price were related to the female folks. Also, the male tomato producers' profitability was significantly affected by the seed costs, the quantity grown and the selling price while the female producers' profitability was significantly influenced by the level of education, experience, labour costs, fertilizer costs, farm size, selling price and distance to the market.

Determinants of extent of commercialization among arable crop farmers. To assess the market performance of the small scale, crop producers, many researchers have delved into empirical works on commercialization of crop outputs and its determinants. For example, Ele *et al.* (2013) determined the household commercialization index among farming households in Cross River State, Nigeria. Findings showed that the total quantity of food crop produced, farming experience, access to agricultural extension service, size of land used for cultivation, membership in cooperative organization and household size were important factors determining the level of commercialization of smallholder farms. In a similar study, Oparinde and Daramola (2014) identified determinants of market participation by maize farmers in Ondo State, Nigeria. The results showed that the age of the household head, experience of the household head, cropping system used, the quantity of harvested output, farm size, land tenure and unit price of output had significant influence on the intensity of market participation by maize farmers in the rural and peri-urban areas of the State. In a similar Venn, Egbetokun *et al.* (2014) estimated determinants of output commercialization among crop farming households in the South-Western region of Nigeria. The results revealed that information on the price of the commodity, household size, farm size, farming experience and access to extension workers were the major determinants of output commercialization of crop farmers in the region. Also, Adenegan (2015), investigated smallholder cassava commercialization in Oyo State, Nigeria. Results showed that education and farm size had significant relationships with household commercialization. Besides, Olanrewaju *et al.* (2016) assessed crop commercialization among smallholder farming households in the southwest region of Nigeria. The assessment showed an average household commercialization index of 0.83. The empirical results showed that age, gender, level of education, household size, membership of an association, farm size, access to credit, farm and off-farm income, were associated with an increase in the extent of crop commercialization. Salisu *et al.* (2018) examined the factors that affect market participation of smallholder farmers in Ghana. Findings showed that being a female farmer, having access to credit, increase in farm size and household size were factors that encourage market-oriented farming.

Research Gap. Few related studies analyse the gross margins and degree of commercialization of vegetable crop production in the southern region of Nigeria, and the need to update the findings is overwhelmingly necessary in order to reflect the current realities. Likewise, very few studies have sought to analyse the performance of vegetable production under different land management techniques in Nigeria. The country needs more empirical findings or information to be able to develop a holistic policy package that is suited for sustainable vegetable production in the State, hence the justification for this research. The research findings will also give policymakers and other stakeholders' opportunities to assess Waterleaf enterprise as an emerging source of sustainable livelihood activity capable of reducing rural poverty in the region.

The purpose of the article – to achieve the main objective of the study, the specific objectives were stated as follows:

a) compare the socioeconomic characteristics of organic manure and fertilizer based Waterleaf farmers in Uyo agricultural zone,

b) estimate the gross margins and determine factors that affect it among organic and fertilizer based Waterleaf farmers in Uyo agricultural zone and,

c) estimate the extent of commercialization and factors that influence it among organic manure and fertilizer based Waterleaf farmers in Uyo agricultural zone.

Research methodology. Study Area. The study was conducted in Uyo agricultural zone in Akwa Ibom State, Nigeria. Akwa Ibom State has six agricultural zones namely: Uyo, Oron, Eket, Ikot Ekpene, Etinan, and Abak. Uyo Agricultural zone covers extension activities in Uyo, Ibesikpo Asutan, Itu, Uruan and Ibiono Ibom Local Government Areas. Crops widely grown in the area are leafy vegetables such as Waterleaf, fluted pumpkin and garden egg. Others include cassava, maize, yam, pepper, plantain, and cucumber. Some households grow cash crops such as oil palm, rubber, and cocoa.

Source of Data and Instrument for Data Collection. Primary data were used in the study and these included socioeconomic, cost and production data among others. The questionnaire was adequately structured to suit the intended objectives and was administered to the intended respondents and complemented by personal interviews to ensure the consistency and accuracy of data collected.

Sample Size Selection. From Cochran (1963), a representative sample size from a large population of Waterleaf farmers in the study area was obtained using the equation (1) specified as thus:

$$S_n = \frac{z^2\rho(1-\ \rho)}{D^2} \qquad (1)$$

Where S_n is the required sample size; Z is the 95% confidence interval (1.96); P is the expected proportion of Waterleaf farmers in total farmers' population in the study area (about 85%); D is the absolute error or precision at 5% type 1 error. The sample size is derived as shown in equation 2

$$S_n = \frac{(1.96)^2 0.85(1-\ 0.85)}{(0.05)^2} = 196 \qquad (2)$$

For convenience and proportional sampling, a representative sample was scaled up to 240 respondents, consisting of 120 organic-based farmers and 120 fertilizer based farmers.

Sampling Procedure and Sample Size. Farmers who used only poultry litter and or other forms of organic manures were classified as organic-based Waterleaf farmers and those that used one or more type of synthetic fertilizer only or with combination with poultry litter or any other form of organic manures were classified as inorganic or fertilizer based Waterleaf farmers. Multi-stage sampling technique was adopted in selecting respondents for the study.

The first stage involved the random selection of three local government areas of the zone. The second stage involved the random selection of five villages from each local government noted for intensive Waterleaf production. A total of 15 villages from three local government areas was used in the study. The third stage involved a random selection of sixteen Waterleaf farmers (consisting of eight organic and eight inorganic based Waterleaf farmers) from each of the villages selected. A total of two hundred and forty respondents (comprising of one hundred and twenty organic-based Waterleaf farmers and one hundred and twenty fertilizer based Waterleaf farmers) were selected. Based on logistic and appropriateness of respondents; the actual distribution of respondents in the three local government areas is shown in table 1.

Table 1

Distribution of respondents in the selected LGAs in Uyo agricultural zone

LGA	Fertilizer based farmer		Organic-manure based farmer	
	Frequency	Proportion (%)	Frequency	Proportion (%)
IbesikpoAsutan	38	31.67	38	33.08
Uyo	44	36.67	44	33.84
Itu	38	31.67	38	33.08
Total	120	100.00	120	100.00

Source: tabulated by author, 2018.

Analytical Techniques. Descriptive statistics consisting of percentages, tables, means, and frequencies were used. Besides, the Student t-test was employed to test whether selected socioeconomic characteristics of organic or manure-based Waterleaf farmers were significantly different from fertilizer based Waterleaf farmers in the zone. In the formulae given below; X_1 and X_2 represents the means of the two samples, Δ is the hypothesized difference between the population means (0 if testing for equal means), S_1 and S_2 are the standard deviations of the two samples, and n_1 and n_2 are the sizes of the two samples. The number of degrees of freedom for the problem is the smaller of $n_1 - 1$ and $n_2 - 1$.

$$t = \frac{X_1 - X_2 - \Delta}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_1}}} \tag{2}$$

The null hypothesis for the difference in socioeconomic features of respondents from the two groups was tested using the calculated t-test value and the tabulated t-value.

Gross Margins of Organic and Fertilizer based Waterleaf Farmers in Uyo Agricultural Zone. The gross margin estimated for organic manure and fertilizer based Waterleaf farmer is defined as follows:

$$GM = Total\ Revenue - Total\ Variable\ \ cost \tag{3}$$

The gross margin was estimated for each farmer and covers a year production cycle. The difference in gross margins for the two groups was tested. Total revenue consisted of annual revenue (i.e. Revenue for one full production cycle) from Waterleaf sales. Total Variable cost consisted of annual costs of labour, weeding, watering, manure/fertilizer, land clearing, planting materials and cost of preparing Waterleaf beds as well as transportation cost.

Factors that influence the gross margin of organic and fertilizer based Waterleaf farmers. A multivariate regression model based on the Ordinary Least Squares estimation method was used to determine factors affecting the gross margin of Waterleaf farmers in the region. The choice of the model and estimation method was based on the fact that all dependent variables were greater than zero. Implicitly, the specified model is expressed as thus:

$$GM = \delta_0 + \delta_1 AGE + \delta_2 EDU + \delta_3 MAR + \delta_4 FER + \delta_5 FAS + \delta_6 FAI + \delta_7 HHS + \delta_8 SOC + \delta_9 EXP + \delta_{10} COS + \delta_{11} CRE + \delta_{12} GEN + \delta_{13} THF + \delta_{14} PHL \quad (4)$$

where,

GM = Gross margin of a farmer (Naira) in one-year production cycle
AGE = Age of farmer (year)
EDU = Education of a farmer (year)
MAR = Marital status (dummy: 1 for married and 0 otherwise)
FER/MAN = Cost of planting Material (Naira)
FAS = Farm size (hectare)
FAI = Farm income (Naira)
HHS = Household size (number)
SOC = Member in social organization (year)
EXP = Farming experience (year)
COS = Cost of hiring labor (Naira)
CRE = Access to farm credit (amount in Naira)
GEN = Gender of a farmer (dummy: 1 for female and 0 otherwise)
THF = Value of crop stole (quantity stolen multiply by market price)
PHL = Value of post-harvest lost (quantity lost by spoilage multiply by the market price)

Note, this equation was estimated for organic and fertilizer based Waterleaf farmers in the zone.

Measuring the degree of commercialization/market share of organic and fertilizer based Waterleaf farmers in Uyo agricultural zone. Following the work of von Braun *et al*. (1994), output commercialization degree of Waterleaf farmers was measured as follows:

$$COM = \frac{Total\ value\ of\ waterleaf sold\ by\ a\ farmer}{total\ value\ of\ waterleaf\ produced\ by\ a\ farmer} \quad (5)$$

Note, values in equation 5 are described as: $\frac{\sum_{n=1}^{n} P_s Q_s}{\sum_{n=1}^{n} P_s Q_t}$

Where Ps is a market price of Waterleaf and Qs is the quantity of Waterleaf willing offer for sale by a farmer while Qt is the total quantity of Waterleaf produced by a farmer. "COM" is the degree of commercialization or market share of organic or fertilizer based Waterleaf farmers and its range from 0 to unity. The index value of "0" denotes full subsistence farmer; while an index value greater than zero but less than unity (0<COM<1) is described as partly commercialized farmers. Also, the index value of 1 indicates full commercialized farmers. The student t-test was used to test the difference in the degree of commercialization in organic and fertilizer based farmers.

Determinants of commercialization among organic manure and fertilizer

based Waterleaf farmers in Uyo agricultural zone. A multivariate regression model based on the Ordinary Least Squares estimation method was applied to determine factors affecting the degree of commercialization of organic manure and fertilizer based Waterleaf farmers in the study area. The choice of the model and estimation method was conditioned on the fact that all dependent variables were greater than zero. Implicitly, the specified model is expressed as thus:

$$MSH = \beta_0 + \beta_1 AGE + \beta_2 EDU + \beta_3 GEN + \beta_4 EXP + \beta_5 HHS + \beta_6 FAS + \beta_7 SOC + \beta_8 HDR + \beta_9 MAR + \beta_{10} EXT + u_i \quad (6)$$

where,

MSH = Commercialization level of a farmer
AGE = Age of the farmers (years)
EDU = Education level of the farmer (years)
GEN = Gender (dummy, 1 for female farmers and 0 for male farmers)
EXP = Farming experience (years)
HHS = Household size (Number)
FAS = Farm size (ha)
SOC = Membership in a social organization (Number of years)
HDR = Household dependent ratio (number of children less than 15 years plus adult greater than 65 year divided by the household size)
MAR = Marital status of a farmer (dummy, 1 for married and 0 otherwise)
EXT = Access to extension services (number of times per one-year production cycle).

Results and discussion. ***Analysis of the socioeconomic characteristics of organic and fertilizer based Waterleaf farmers in Uyo agricultural zone.*** The social and economic characteristics of organic and fertilizer based Waterleaf farmers in Uyo agricultural zone, Nigeria is presented in tables 2, 3, 4 and 5. Findings revealed that the majority representing 69.20 % and 81.70 % of fertilizer and organic manure-based Waterleaf farmers respectively were female. The finding implies that Waterleaf enterprise irrespective of the soil management technique adopted in the southern region of Nigeria is dominated by the female folks. Also, the age distribution reveals that the majority of fertilizer (55.00 %) and organic manure (37.50 %) based farmers fell in the age bracket of 31–40 years. Their mean ages stood at 37.03 years and 41.89 years for fertilizer and organic manure-based farmers respectively, and are statistically different from each other at 1 % probability level. None of the farmers were below 20 years. The result connotes that the majority of Waterleaf farmers in the region are in their active years and are relatively youthful.

The results also showed that the majority of fertilizer (84.20 %) and organic manure (66.67 %) based Waterleaf farmers were married in the region. This implies that the majority of Waterleaf farmers are housewives and perhaps engaged in the business to raise complementary household income. Besides, the majority of both groups of farmers were found to be literate and had received up to secondary school level education.

Table 2

Socioeconomic Features of Organic Based and Inorganic Based Waterleaf Farmers in Uyo Agricultural Zone in Akwa Ibom State

Socioeconomic Characteristic	Fertilizer based Farmer		Organic-based Farmer	
Gender	Frequency	Percentage	Frequency	Percentage
Male	87	30.80	22	18.30
Female	33	69.20	98	81.70
Total	120	100.00	120	100.00
Age distribution (years)				
≤ 20	0	0.00	0	0.00
21–30	21	17.50	26	21.70
31–40	66	55.00	45	37.50
41–50	23	19.67	31	25.80
51–60	10	8.33	7	5.80
>60	0	0.00	11	9.20
Total	120	100.00	120	100.00
Mean	37.03		41.89	
$t_{(value)}$ = 37.03*** d.f= 119 sig. =0.000				

Source: computed by authors, 2018.

Table 3

Socioeconomic Features of Organic Based and Inorganic Based Waterleaf Farmers in Uyo Agricultural Zone in Akwa Ibom State

Socioeconomic Characteristic	Fertilizer based Farmer		Organic-based Farmer	
Marital status	Frequency	Percentage	Frequency	Percentage
Single	19	15.80	29	24.17
Married	101	84.20	80	66.67
Divorced	0	0.00	0	0.00
Widowed	0	0.00	11	9.17
Total	120	100.00	120	100.00
Education (years)				
No education	0	0/00	0	0/00
Primary	13	10.80	11	9.20
Secondary	85	70.80	60	50.00
Tertiary	22	18.30	49	40.80
Total	120	100.00	120	100.00
Mean	10.53		12.04	
$t_{(value)}$ = - 4.677; d.f = 119; sig. = 0.000				
Household size				
1–5	73	60.83	34	28.33
6–10	46	38.33	70	58.33
>10	1	0.83	16	13.33
Total	120	100.00	120	100.00
Mean	5.00		4.00	
$t_{(value)}$ = - 4218; d.f = 119; sig. = 0.000				

Source: computed by authors, 2018.

The result suggests that these farmers have a high probability to adopt and use agricultural innovations. The average years of formal education stood at 12.04 years and 10.53 years for organic manure and fertilizer based farmers respectively. However, the null hypothesis of no difference in years of formal education received by the two groups of Waterleaf farmers was rejected. By implication, years of formal education received by fertilizer based Waterleaf farmers were higher than and significantly different from the organic manure-based Waterleaf farmers in the region.

Table 4

Socioeconomic Features of Organic Based and Inorganic based Waterleaf Farmers in Uyo Agricultural Zone in Akwa Ibom State

Socio-economic Characteristics	Inorganic Farmers		Organic Farmers	
Farming Experience (years)	Frequency	Percentage	Frequency	Percentage
1–10	110	91.70	115	95.80
11–20	10	8.30	5	4.20
21–30	0	0/00	0	0.00
>30	0	0.00	0	0.00
Total	120	100.00	120	100.00
Mean	6.65		6.90	
$t_{(value)}$ = 0.618; d.f = 119; sig = 0.538				
Social Organization				
0	111	92.50	103	85.80
1–10	9	7.50	17	14.20
11–20	0	0.00	0	0.00
>20	0	0.00	0	0.00
Total	120	100.00	120	100.00
Mean	0.125		0.830	
$t_{(value)}$ = -3.049***; d.f = 119; sig. = 0.003				
Land Ownership				
Inheritance	78	65.00	75	62.50
Leased	25	20.8-	29	24.20
Contract	5	4.20	0	0.00
Purchase	12	10.00	16	13.30
Cooperative	0	0.00	0	0.00
Communal	0	0.00	0	0.00
Total	120	100.00	120	100.00
Extension access				
0	108	90.00	109	90.80
1–5	12	10.00	11	9.20
>5	0	0.00	0	0.00
Total	120	100.00	120	100.00
Mean	0.125		0.490	
$t_{(value)}$ = - 2.369**; d.f = 119; sig. = 0.019				

Source: computed by authors, 2018.

The household size distribution revealed that the majority (60.83 %) of fertilizer based farmers has a family size ranging from 1–5 members while the majority (58.33 %) of the organic manure-based farmers has 6–10 household size. It is observed that the volume of labour used in Waterleaf production by most of the farmers in the region came from the household labour or imputed labour.

Hence, farmers that have fewer household members would prefer less laborious soil management strategy like fertilizer compared to strenuous and bulky technology found in organic manure technology. The mean household size of 5 and 7 persons was obtained for the fertilizer based and organic-based Waterleaf farmers' respectively. Furthermore, the study rejected the null hypothesis of no significant difference in the family size distribution of the two groups of farmers. This implies that the household size of farmers that utilized organic manure differs significantly from those farmers who utilized fertilizer.

Table 5

Socioeconomic Features of Organic Based and Inorganic Based Waterleaf Farmers in Uyo Agricultural Zone in Akwa Ibom State

Socioeconomic Characteristics	Inorganic Farmers		Organic Farmers	
Farm Income (naira)	Frequency	Percentage	Frequency	Percentage
≤10,000	10	8.30	14	11.70
10,001–30,000	66	55.00	69	57.50
30,001–50,000	3	2.50	36	30.00
50,001–70,000	36	3.00	1	0.80
>70,000	5	4.20	0	0.00
Total	120	100.00	120	100.00
Mean	34203.33		24861.83	
$t_{(value)}$ = 4.556***; d.f = 119; sig = 0.000				
Farm size (ha)				
≤0.01	19	15.80	56	46.70
0.011–0.05	85	70.80	64	53.30
0.051–0.10	13	10.80	0	0.00
0.11–0.5	3	2.50	0	0.00
>0.5	0	0.00	0	0.00
Total	120	100.00	130	100.00
M ean	0.024		0.013	
$t_{(value)}$ = 4.798***; d.f = 119; sig = 0.000				

Source: computed by authors, 2018.

The study also discovered the mean years of farming experience of 6.65 years and 6.90 years for fertilizer and organic-based farmers respectively. This implies that Waterleaf farmers are relatively young in the business and Waterleaf production is an emerging crop enterprise in the zone. The t-test showed that the distribution of farming experience was not statistically different between the two groups of farmers.

Besides, results revealed that the social capital formation among Waterleaf farmers in the zone was very poor. About (85.8 %) and (92.5 %) of fertilizer and organic manure-based Waterleaf farmers respectively do not belong to any social group(s). The mean years of social interaction indicated 0.83 years for organic farmers and 0.23 years for fertilizer based counterpart in the zone. However, the mean years of membership in social organization significantly differs for the two groups of farmers. The land is known to be one of the limiting inputs in agriculture due to population growth and increasing urbanization. On the mode of land acquisition, the majority of organic (65.0 %) and fertilizer based (62.5 %) farmers acquired land through inheritance.

The result of the agricultural extension visit revealed that the majority of organic manure (90.8 %) and fertilizer based (90.0 %) farmers had no access to extension services for the past one year. The mean number of extension visits in a year for organic manure and fertilizer based farmers stood at 0.46 times and 0.125 times respectively. Also, the result rejected the null hypothesis with regard to equality in the number of times of extension agent visits and rather affirms that the number of times, organic and fertilizer based Waterleaf farmers accessed agricultural extension agents differ significantly.

The mean farm income for fertilizer based farmers stood at ₦34203.33 while that of organic manure farmers was ₦24861.83. Further analysis revealed that farmers that utilized fertilizer had higher farm income that was significantly different from the farm income realized by organic manure farmers at 1% probability level.

The analysis of farm size revealed that farm size (measure in hectare) used by Waterleaf farmers in the study area was generally low. The mean farm size stood at 0.024 ha and 0.013 ha for fertilizer users and organic manure users respectively. The null hypothesis of no significant difference in land distribution for the two groups of farmers was rejected, implying that landholding for fertilizer based farmers are higher and significantly different from organic manure-based farmers in the region.

Gross margin of organic-based and fertilizer based Waterleaf farmers.

The estimated gross margins of organic-based and fertilizer based Waterleaf farmers are categorized and presented in table 6. Findings reveal that only 15.0 % of organic-based Waterleaf farmers obtained gross margin in the lowest range of ₦1000 to ₦5000 per production cycle; while 10.0 % of fertilizer based fell into this same category. No organic-based Waterleaf farmer was able to make up to ₦40001–₦50000 gross margin range and above; whereas 0.80 % and 5.0 % of fertilizer based farmers fell into these categories respectively.

The result further revealed that the majority (32.5 %) of organic manure-based farmers realized their gross margin in the range of ₦10,000 – ₦20,000; while 49.2 % of fertilizer based farmers also realized their gross margin in the same range. Based on the magnitude of above gross margin distribution; it seems fertilizer based Waterleaf farmers are more commercially oriented compared to organic-based farmers. The mean gross margin for organic manure farmers stood at ₦18, 783.12 per production cycle while that of fertilizer based farmers was ₦ 17,335.00. The maximum gross margin stood at ₦39, 000.00 for organic manure based farmers and ₦57, 350.00 for fertilizer based. By comparing the gross margin of the two groups using a t-test, the null hypothesis of no significant difference were accepted. The implication is that the gross margin of organic manure and fertilizer based Waterleaf farmers is statistically similar. This suggests that the gross margin of Waterleaf farmers in the zone is statistically the same irrespective of the type of soil enhancing materials used.

Table 6

Gross margins of organic and fertilizer based Waterleaf Farmers in Uyo Agricultural Zone

Gross margin (Naira)	Organic manure-based farmer		Fertilizer based farmer	
	Frequency	Percentage	Frequency	Percentage
1000–5000	18	15.00	10	8.30
5001–10000	16	13.30	9	7.50
10001–20000	39	32.50	59	49.20
20001–30000	31	25.80	16	13.30
30001–40000	16	13.30	19	15.80
40001–50000	0	0.00	1	0.80
>50000	0	0.00	6	5.00
Total	120	100.00	120	100.00
Mean	17,335.00		18,783.12	
Maximum	39,000.00		57,350.00	
Minimum	1000.00		1600.00	
t(value)=1.112 d.f =119; sig = 0.269				

Source: computed by authors, 2018.

The difference in maximum gross margin obtained by the two groups of farmers is supported by the reports of Amadou and Barbier (2015) and Henri-Ukoha *et al.* (2015).

Factors that Influence the Gross Margin of Organic and Fertilizer based Waterleaf Farmers in Uyo Agricultural Zone.

Multicolearity of explanatory variable. The estimates presented in table 7 are results of variance inflating factor (VFI) test used to verify the status of multicollinearity among the explanatory variables used in the OLS regression model. The result revealed that there is no serious or significant collinearity among the explanatory variables. The estimated VIF concerning each variable was greater than unity, but less than the threshold value of 10. The tolerance factor was also less than unity, validating the VFI results. The result implies that the explanatory variables specified do not cluster together or exhibit multicollinearity tendencies. This implies that the estimates of the gross margin equation are consistent, best and unbiased.

The estimates of the gross margin equations are presented in table 8. The diagnostics, statistics of the estimated models revealed the R^2 value of 0.799 and 0.982 for the organic and fertilizer based Waterleaf farmers' gross margin equation respectively. This implies that about 79.9 % and 98.2 % of the variations in gross margins of organic and fertilizer based farmers respectively is explained by the specified explanatory variables in each model. This means that important variable that influenced variations in gross margin of organic and fertilizer based Waterleaf farmers were included in the specified gross margin equations.

Table 7

The Variance Inflation Factor (VIF) test result

Variables	VIF Estimate	Tolerant Ratio
Age	1.799	0.556
Education	1.744	0.573
Marital status	2.054	0.487
Stem cost	2.576	0.388
Farm income	6.381	0.157
Household size	2.550	0.392
Social organization	2.249	0.445
Farm experience	3.133	0.319
Labour	3.838	0.261
Farm credit	2.439	0.410
Qty stolen	2.596	0.385
Qty spoilt	2.081	0.481
Gender	1.627	0.615
Farm size	1.829	0.547

Source: estimated from Gretl software, 2018.

The F – calulated ratios of 53.44 for organic-based model and 411.35 for fertilizer based model were significant at the 1 % probability level, which implies that the estimated R^2 were significant and by implication, the models have the goodness of fits. The diagnostic tests further revealed a significant (at the 1 % level) RESET test ratio of 32.29 for organic manure-based equation and 22.10 for fertilizer based equation. This implies that the estimates in the models showed structural rigidity and this justifies the use of the Ordinary Least Squares estimation method. The normality test is significant at 1 % probability level of organic and fertilizer based models. This means that the distribution of the variance of the error terms in both models assumed a normal curve. It implies that an increase or reduction in the sample size will result in an exact or similar change in the value of the estimation variables. The White test ratio is significant at 1 % probability level for both models and indicates that the variances of the error terms are relatively constant.

The empirical results indicate that the coefficient of age is positive and significant at 1 % probability level for fertilizer based model. This implies that a 1 % increase in the age of fertilizer based Waterleaf farmers would increase the gross margin by ₦221.75. However, age is not a significant determinant of gross margin for organic-based Waterleaf farmers in the zone. The finding could be because older farmers tend to have more farming experience and hence will adopt techniques that will help them allocate and combine farm resources efficiently. The finding corroborates the report of Ndungu *et al.* (2013), but is contrary to the finding of Rugube *et al.* (2019).

The result further revealed that education has a positive significant relationship with the gross margin of organic-based farmers, but a negative relationship with fertilizer based farmers. The result showed that an increase in years of formal education will cause about ₦85.48 increase in gross margin of organic-based farmers and ₦202.21 reduction in the gross margin of inorganic based farmers. This implies that more educated Waterleaf farmers tend to use more of organic manure and less of fertilizer technology.

Table 8

Determinants of gross margin among organic and fertilizer based Waterleaf Farmers in Akwa Ibom State, Nigeria

Variable	Organic manure based farmer		Fertilizer based farmer	
	Coefficient	t-value	Coefficient	t-value
Constant	−898.431	−1.292	−497.455	−0.3449
Age	−8.887	−0.817	221.751	6.894***
Education	85.477	2.405**	−202.211	−2.491**
Marital status	−134.509	−0.824	−2826.01	−4.405***
Stem cost	−0.990	−48.44**	−1.5332	−16.48***
Farm income	0.968	93.01***	0.8595	41.18***
Household size	−107.829	−2.576**	−345.850	−3.108***
Social group	−193.421	−4.540***	−1185.82	−3.824***
Farm experience	−18.939	−0.741	−72.9380	−0.8837
Labour cost	−1.001	−37.48***	−0.820	−19.44***
Farm credit	−0.062	−6.658***	−0.019	−0.6953
Qty. Theft	0.182	0.605	−0.0837	−2.380**
Qty. Spoilt	−0.078	−1.943*	−0.0463	−0.5770
Gender	719.551	4.142***	−2891.39	−6.407***
Farm size	3123.21	0.173	−40078.4	−4.544***
Diagnostic tests				
R-squared		0.799	0.982	
F(14, 105)		53.438***	411.35***	
Log-likelihood		−882.652	−1061.053	
Adjusted R-squared		0.6984	0.979	
RESET test		32.2900***	2 2.10***	
White's test for heteroskedasticity		74.2736***	120.00***	
Normality test		28.8459***	32.496***	
Chow test for structural break at observation 120		Chi-square (15) = 356.6 with p-value 0.0000. F-form: F(15, 210) = 23.7775 with p-value 0.0000		

Source: from data analysis using Gretl econometric software, 2018. The asterisks `*`, `**` and `***` show significance at 10 %, 5 %, and 1 % probability level respectively.

The result could be partly explained by the cultural believed prevalence in the region that emphasized that, Waterleaf produced from organic sources are more tasty and nutritious than fertilizer source. Hence, more educated farmers would probably adjust to consumers' demand than less educated ones. In another view, the finding could be assigned to the low cost per unit and relatively available forms of several organic manures accessible to farmers compared to higher price per unit and relatively scare fertilizer input in the zone. As well, it seems more educated Waterleaf farmers are aware of the risk inherent in the continuous utilization of fertiliser. There are other issues such as environmental pollution, chemical burnt to tender crops, underground water pollution, and acidification of the soil as well as the toxicity of nutrients in plants. More educated farmers would try to avoid excessive usage of fertilizer and this will perhaps contribute to a lower yields including low gross margins. The findings are in consonance with the submissions of Xaba and Masuku (2013) and Singh *et al.* (2017).

The result also showed that an increase in marital status decreases the gross margin of fertilizer based farmers by ₦2826.01. This could be because married farmers often receive more responsibilities that would possibly go to an increase in household expenditures an opportunity cost of acquiring expensive farm input like fertilizer. This might contribute to a decrease in farm productivity and hence their gross margins. Still, the coefficient of marital status was not significant in determining the gross margin of organic-based Waterleaf farmers.

The findings also revealed that the cost of Waterleaf stem has a significant negative influence on the gross margins of both organic and fertilizer based Waterleaf farmers. The result showed that a unit increase in the cost of Waterleaf stem will significantly reduce the gross margin of organic and fertilizer based farmers by ₦0.990 and ₦1.53 respectively. An increase in the cost of planting material would lead to an increase in the cost of production, which consequently reduces the total revenue and gross margin of farmers. Similar reports have been submitted by Ndungu *et al.* (2013); Ridwan *et al.* (2014); and Singh *et al.* (2017).

The coefficients of farm income in both models showed a significant positive impact on gross margin. The result revealed that; increase in farm income of organic and fertilizer based Waterleaf farmers will lead to the respective increase in the gross margin of the farms. This means that as income earned from Waterleaf production is widened, the gap between revenue earned and variable cost also widens. The surplus of total revenue over total cost is very useful in facilitating the acquisition and efficient management of farm resources and also receives a positive implication on the gross margins of farmers. However, this finding does not agree with the report of Rugube *et al.* (2019).

The result also revealed that the increase in household size impacted negatively on organic and fertilizer based Waterleaf farmers' gross margin. The result showed that a unit increase in the household-size of organic and fertilizer based farmers will reduce the gross margins by ₦107.83 and ₦345.85 respectively. This means that farmers with large household size will likely allocate most of their financial resources to the family's essential needs rather than farm investment. Lower farm investment would lead to lower input productivity and lower yields as well as lower-income and gross margin. Fakkhong and Suwanmaneepong (2016) and Rugube *et al.* (2019) confirm this report previously.

The coefficients of social capital formation are negatively related to the gross margin of organic and fertilizer based farmers. Findings revealed that an increase in social capital formation will lead to ₦193.42 and ₦1185.82 reduction in the gross margin of organic and fertilizer based farmers respectively. This could be as a result of the fact that few farmers who belong to social groups may have more financial obligations inform of levies and periodic contributions to the group they belong compared to non- members. This could add to the farmers' total cost and lead to a reduction in gross farm investment and farmers' gross margin. This suggestion could be the likely reason why many of the Waterleaf farmers' do not belong to social organization(s).

The cost of hiring labour has a significant marginal negative impact on the gross margin of both groups of farmers in the zone. Findings showed that the increase in labour cost will marginally reduce gross margin by ₦1.001 and ₦0.820 for organic and fertilizer based Waterleaf farmers respectively. Waterleaf production is labour-intensive and most of the time the imputed or family labour is readily available and constitutes the greater part of labour cost compared to hired labour. Increase expenditure on labour would result to increase in production cost and subsequent decrease in the gross margins of farmers. The following researchers have reported similar findings, Ndungu *et al.* (2013); Ridwan *et al.* (2014); and Singh *et al.* (2017).

Furthermore, the result revealed that access to credit correlates negatively with the gross margin of organic-based farmers. It showed that increased access to farm credit will lead to about ₦0.062 marginal decrease in the gross margin of farmers. This perhaps could mean that as farmers get increased access to farm credit; they are more likely to benefit from economies of scale that could lead to cost increase and lesser gross margin. The issues of interest rate and collateral submission could also explain the result discussed above. Servicing high-interest rate would reduce farm total income. However, this variable did not react significantly to the gross margin of fertilizer based farmers.

The slope coefficient of the quantity of Waterleaf stolen relates negatively to the gross margin of fertilizer based farmers. The result showed that a unit increase in the quantity of Waterleaf stolen will result in a marginal decrease in the gross margin by ₦0.084. The use of fertilizer is often associated with elegant and luxuriant growth in Waterleaf that easily attracts the attention of passersby, hence is prone to pilfering at first sight. Continuous or significant pilfering is capable of reducing farm income, thereby lowering the farm's gross margin.

The result of gender revealed the importance of the female in Waterleaf production in the study area. Findings revealed that an increase in female composition would trigger an increase in the gross margin of organic-based farmers by ₦719.551 and a reduction of ₦2891.39 of fertilizer based farmers. From the result, it implies that resource-poor women preferred the use of organic manure to fertilizer. This choice could be driven by several factors including price, cultural issues and its availability among others. The finding is in agreement with the previous submissions by Fakkhong and Suwanmaneepong (2016) and Rugube *et al.* (2019).

The finding further reveals that farm size has a significant negative relationship with the gross margin of fertilizer based farmers. It showed that as farm sizes increase, it leads to a reduction in the gross margin of fertilizer based farmers by ₦40078.4, at the 1 % level of probability. This can be explained by the fact that an increase in farm size would lead to an increase in the number of farm inputs needed, which will also lead to an increase in the cost of production. With the current land intensification by the Waterleaf farmers in the zone; an increase in farm size will be followed by an increase in farm investment including soil enhancing materials. Besides, the relative price of fertilizer is the major driving force for this relationship among small scale farmers in the zone. However, farm size did not have a significant relationship with the use of organic manure. The findings are supported by the empirical findings of Fakkhong and Suwanmaneepong (2016) and Singh *et al.* (2017).

Based on the magnitude of the variable' coefficient, the analysis has revealed that farm size, gender, marital status of a farmer and household size are the most critical factors that affect the gross margins of both organic manure and fertilizer based Waterleaf farmers in the zone.

Output commercialization/market share of organic-manure and fertilizer based Waterleaf farmers in Uyo agricultural zone, Nigeria. The result in table 9 shows the distribution of extent of commercialization of organic and fertilizer based Waterleaf farmers in the study area.

Table 9

Results showing the market share of organic and inorganic based Waterleaf farmers

Category of commercialization	Fertilizer based farmers		Organic-based farmers	
	Frequency	Percentage	Frequency	Percentage
0.000	0	0	0	0
0.010 – 0.300	4	3.33	0	0
0.301 – 0.600	12	10	19	15.83
0.601 – 0.900	67	55.83	56	46.67
0.901 – 0.900	37	30.83	45	37.5
Total	120	100	120	100
Mean	0.792		0.804	
Maximum	0.970		0.960	
Minimum	0.125		0.366	
t- test	$t_{(value)}$ = -2.407; d.f = 119; sig. = 0.018**			

Source: computed by author, 2018.

The result revealed that the majority of organic-based (55.83) and fertilizer based (46.67 %) farmers had market share in the range of 0.601–0.900 on the maximum scale of unity. The mean market share of 0.792 and 0.804 were obtained for fertilizer and organic manure-based Waterleaf farmers in the zone. No Waterleaf farmer had an index of zero or unity, implying that none of them practiced all subsistence production or commercialization. This means that, Waterleaf production in the region, whether it is organic manure or fertilizer based has an increasing element of market – orientation and the decreasing element of subsistence production. The null hypothesis of no difference in the market share of organic and fertilizer based farmers was rejected at the 5 % probability level. This implies that the market share or the level of commercialization of organic-based Waterleaf farmers is statistically different from fertilizer based farmers.

Determinants of market share of organic and fertilizer based Waterleaf farmers in Uyo agricultural zone.

The Variance Inflation Factor (VIF) test result. The test for multicollinearity was conducted for explanatory variables used in the market share equations and the results is presented in table 10. Results revealed that there was no significant collinearity among explanatory variables.

Table 10

The Variance Inflation Factor (VIF) test result

Variables	VIF Estimate	Tolerant Ratio
Age	1.587	0.630
Education	1.759	0.569
Gender	1.303	0.767
Farm Experience	1.770	0.565
Household Size	2.237	0.447
Farm Size	1.674	0.597
Social Organization	1.651	0.606
Household Dependents	1.330	0.752
Marital Status	2.123	0.471
Extension Access	1.360	0.735

Source: compute by authors, 2018.

The estimated VIF concerning each variable was greater than unity, but less than the threshold value of 10. The tolerance factor was also less than unity implying that explanatory variables specified do not cluster together. The estimates of the market share equation for fertilizer and organic-based Waterleaf farmers are presented in table 11. The diagnostics, statistics of the estimated models revealed R^2 values of 0.834 and 0.683 for fertilizer and organic manure-based farmers respectively. This implies that about 83.4 % and 68.3 % of variability in the market share of fertilizer and organic manure-based farmers respectively are connected to the specified explanatory variables. This means that important variable that influenced the market share of fertilizer and organic-based Waterleaf farmers were included in the specified models. The F-cal ratios of both models are statistically significant at 1 % probability level. This indicates that the specified model has strong explanatory power, hence goodness of fit. The RESET tests confirm the presence of structural rigidity in both models. The normality test for both models also confirmed the relevance of the ordinary least squares estimation method. The chow test ratio is significant at the 1 % level of probability and shows that there is a structural break of the pool data at 120 observations. This means that separate regression for the independent data sets (i.e. The two groups of farmers) deliver better modelling than a combined regression. This also implies that the two groups of data and estimates are statistically independent.

The result revealed that a unit increase in age of fertilizer based farmers will increase the market share marginally by 0.008 units. This suggests that older Waterleaf farmers utilized more of fertilizer than organic manure to increase their yields and hence market share. This might arrive as the consequence of the adaptive behaviour or acquired knowledge from accumulated periods of experience. On the other hand, age was not a significant factor in the variations of market share or the extent of commercialization of organic-based farmers. Similar results have been submitted by Oparinde and Daramola (2014) and Olanrewaju *et al.* (2016).

Table 11

The Factor that determines the market share of organic and inorganic based Waterleaf farmers

Variable	Fertilizer based farmers			Organic based farmers		
	Coefficient	Std. error	t-value	Coefficient	Std. error	t-value
Constant	0.309	0.114	2.719***	1.557	0.071	21.90***
Age	0.008	0.002	3.446***	−0.002	0.001	−1.343
Education	0.031	0.006	4.838***	0.046	0.006	7.997***
Gender	0.152	0.032	4.794***	0.058	0.035	1.670*
Farm exp.	0.019	0.005	3.813***	0.005	0.005	0.9807
HHS	−0.005	0.001	−5.000***	−0.033	0.005	−6.389***
Farm Size	0.464	0.081	5.698***	9.197	2.464	3.732***
Soc. Org.	0.027	0.008	3.310***	−0.002	0.008	−0.2178
HH Dep. R	−0.014	0.008	−1.742*	−0.017	0.007	−2.429**
Marital S.	−0.066	0.052	−1.252	−0.017	0.029	−2.515**
Ext service	0.026	0.038	0.682	0.025	0.014	1.807*
Diagnostic tests						
R- Squared	0.834			0.683		
F-Cal.	8.347***			23.477***		
Normality test	6.603**			1.607		
RESET test	16.379***			27.432***		
Chow test for structural break at observation 120	F(11) = 115.238 with p-value 0.0000 F(11, 218) = 10.476 with p-value 0.0000					

Source: computed by the author using Gretel econometric software, 2018. The asterisks `*`, `**` and `***` show significance at 10%, 5%, and 1% probability level respectively.

In a similar vein, a unit increase in the level of formal education of farmers increases the market share or output commercialization of fertilizer based farmers by 0.031 units and 0.046 units for organic-based farmers. Thus, this result confirms that as the farmers acquired more knowledge through formal learning, they are able to manipulate efficiently the input mix to increase yields as well as market share. The finding is substantiated by the previous submissions of Adenegan (2015) and Olanrewaju *et al.* (2016).

Furthermore, the result showed that a unit increase in the number of female farmers will lead to 0.152 and 0.580 unit increase in the market share of fertilizer and organic manure-based farmers respectively. This satisfies a *priori* expectation as women constitute the dominant force in Waterleaf production in the study area. In Nigeria, Olanrewaju *et al.* (2016) had similar results.

The result further showed that farming experience of fertilizer based farmers had a positive effect on their market share in the region. The result revealed that a unit increase in farming experience will increase market share of fertilizer based Waterleaf farmers by 0.019 units. This indicates that farmers with more years of experience in Waterleaf production have a strong affiliation with the use of fertilizer. The finding is in agreement with the research reports of Ele *et al.* (2013) and

Egbetokun *et al.* (2014).

Also, the result revealed that household size negatively influenced market shares of farmers. The result revealed that a unit increase in the size of the household will result in 0.001 and 0.033 units decrease in market share of fertilizer and organic-based farmers respectively. This implies that farmers with larger household sizes will likely allocate most of their financial resources to the family's essential needs such as education and food consumption, which could lead to the reduction in farm investment and further yields as well as market share. The finding is supported by Egbetokun *et al.* (2014) but confute with reports of Olanrewaju *et al.* (2016) and Salisu *et al.* (2018)

Conversely, farm size has a positive impact on the market share/commercialization of both fertilizer and organic manure-based Waterleaf farmers in the zone. The result revealed that a unit increase in farm size of both categories of farmers will lead to 0.464 units and 2.464 unit increase in their market shares respectively. Based on the size of the estimated coefficients, it appears that land is the most important factor that affects the use of fertilizer and organic manure soil enhancing materials among Waterleaf farmers in the study area. The finding is strongly supported by the empirical results of Ele *et al.* (2013); Oparinde and Daramola (2014); Egbetokun *et al.* (2014); Adenegan (2015); Olanrewaju *et al.* (2016); and Salisu *et al.* (2018).

Social capital formation among Waterleaf has a significant positive relationship with the commercialization of inorganic based Waterleaf farmers. The result revealed that a unit increase in social capital formation will increase the market share of inorganic based farmers by 0.27 units at 1 % probability level. This finding suggests that farmers connected through group activities are most likely to utilized fertilizer as a soil enhancing material than those that are not connected. Farmers with a high degree of social capital formation have more opportunities to interact and share information and innovation without much obstruction. The finding is supported by the earlier submissions of Ele *et al.* (2013) and Olanrewaju *et al.* (2016).

The household dependent ratio reacted negatively to the market share of both fertilizer and organic-based Waterleaf farmers in the region. The result showed that a unit increase in household dependent ratio will result in 0.014 and 0.017 unit decrease in the market shares of fertilizer and organic-based farmers respectively. Increase in household dependent ratio often goes with an increase in household expenditure and subsequent reduction in aggregate farm investment. If this is the case, farm yields will likely reduce and lead to a reduction in farm revenue as well as the market share.

In a similar Venn, marital status played a significant negative role in the market share of organic-based farmers. An addition to the number of married organic Waterleaf farmers will cause about 0.017 unit decrease in their market share. This could be attributed to the fact that, married farmers are saddled with a lot of household financial responsibilities that are capable of draining farm investment potentials that might likely create instances of low yields and market share.

Conversely, access to agricultural extension service played a positive significant role in the market share of organic Waterleaf farmers. This could be as a result of the fact that farmers with increased access to extension services are more enlightened on the benefits and consequences of using certain farm technology and are also predisposed to choose better options among a set of production techniques based on the knowledge received from extension agents. Ele *et al.* (2013) and Egbetokun *et al.* (2014) reported similar results in Nigeria.

Conclusions. Waterleaf production is an evolving crop enterprise that is capable of being used as a weapon for poverty reduction among resource poor small scale farmers in the southern region of Nigeria. The sustainability of the enterprise is conditioned to developing a sound policy framework that would figure out the current topic of crop intensification while protecting the sub sector for future investment. As part of the contribution to develop a sustainable Waterleaf enterprise in the region, the study compared the economic performance of organic manure and fertilizer based Waterleaf (*Talinum triangulare*) farmers in Uyo agricultural zone, Akwa Ibom State, Nigeria. The results have shown that women dominate the male population in the production of Waterleaf in the region. Also, the majority of Waterleaf farmers are relatively young and is moderately educated. The study has discovered significant differences in some socioeconomic characteristics of organic and fertilizer based Waterleaf farmers in the study area. This implies that the nature of the social and economic characteristics of the Waterleaf farmers contributed to the adoption of the organic manure and fertilizer based production techniques. Besides, the study discovered that the gross margins of organic and fertilizer based Waterleaf farmers were not statistically different from each other. On the other hand, the market share or output commercialization of organic-based Waterleaf farmers was higher and statistically different from the fertilizer based farmers. The findings further identified some important policy variables that are critical in regulating the economic performances of Waterleaf farmers utilizing different soil management techniques. However, the study pinpoints farm size as the most important factor affecting the economic performances of small scale vegetable farmers in the region.

Based on the findings of this research, the following ***recommendations*** are prerequisites to achieving sustainability in the use of soil enhancing materials among small scale vegetable farmers in the Southern region of Nigeria:

1) The governments of the region and all stakeholders in the agricultural sector should as a matter of policy promote adult education programme in farming communities of the State.

2) Government and major or key farmers as well as community leaders should help to strengthen agricultural extension services and its structure should be re-modify to deliver its mandates efficiently to the small scale vegetable farmers in the zone.

3) Subsidy on fertilizer and improved Waterleaf stem/seeds meant for small scale resource-poor farmers are strongly recommended.

4) An increase in information and knowledge about the importance of social capital among small scale Waterleaf farmers in the region is strongly recommended.

This can be achieved through the efforts of the regional governments, community leaders and farmers themselves among other stakeholders.

5) Concerted efforts by the regional governments, groups, NGOs, farmers and local leaders to make available lands to resource poor farmers in the region is highly recommended.

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