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Economic Potentials and Threats to Vegetable Amaranth (*Amaranthus Cruentus*) and Lettuce (*Lactuca Sativa*) Production using Wastewater of Metropolitan Jakara River in Kano, Nigeria

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Abstract: The study determined Amaranth and Lettuce production's profitability and resource-use efficiency in the wastewater drylands along Jakara River in Kano Metropolis, Kano State, Nigeria. A multistage sampling technique was employed for the selection of the respondents. One hundred and eighty (180) producers of Amaranth and Lettuce were selected. Data were collected with the aid of a questionnaire. Data collected were analyzed using descriptive statistics, farm budgeting techniques, and regression analysis. The results of the study revealed that the producers of Amaranth and Lettuce had a mean age of 38 years; mean household size of 7 individuals, mean years of education of 5; mean years of experience of 19 and mean income level of ₦460,567 per annum. The profitability measures have indicated a NFI of ₦213,965/ha and ₦294,287/ha; Return to Naira (*RNI*) of 0.71 and 0.82; Gross Ratio (*GR*) of 0.58 and 0.55; and Operating Ratio (*OR*) of 0.50 and 0.48 for Amaranth and Lettuce respectively, indicating that the production of these crops was profitable. The results also indicated that all the resources used in the production of Amaranth and Lettuce were inefficiently utilized. The land was under-utilized for both crops, while labor, seeds, fertilizer, water, and fuel were over-utilized for both crops; pesticide was over-utilized in Amaranth and under-utilized in Lettuce production. Producing these crops includes unstable products, inadequate farm size, soil erosion, and pests and diseases attack. The study recommends that the producers should utilize all media and other avenues of obtaining market information about input prices to exploit cheaper farm inputs to enhance their profit levels and access loans through their associations from the public and private lending institutions to boost their capital. Federal, State, and Local governments, including International donor agencies, should join hands to control erosion in the production areas.

Keywords: *Profitability, resource-use, amaranth, lettuce, production, wastewater, Jakara river*

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I. INTRODUCTION

Vegetable growing is the most important branch of horticulture in view of the value of its products. About 89 percent of the total production of vegetable is taken in fresh stage while remaining 11 percent processed. Nigeria is abundantly blessed with many varieties of local and some foreign vegetables which are included in business [1], [2]. Generally, the production of vegetable is an important component of the farming systems of the northern states of Nigeria using irrigation. This is because it is a very lucrative economic activity due to the availability of markets in the vicinity of the production areas and in the southern states where there is high demand for them [3]. Some of these vegetables include Lettuce, Amaranth, Cucumber, Watermelon, Carrot, Cabbage, Cauliflower and Okra [4]. Which are all produced along metropolitan Jakara river in Kano.

The fact remains that urban agriculture will complement rural supplies and food will need to continue to be produced in and around cities where there were more peo-

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ple. Urban agriculture will come with the additional benefit of substantially reducing some economically wasteful and environmentally unfriendly costs associated with transportation and packing of agricultural products, as is especially the case when such goods are produced far from their consumers [5]. In many developing areas, however, non-built up urban lands, especially those lying along the courses of urban drainage systems, are sometimes seen as locations for the production of some agricultural products that are in high demand by urban dwellers, such as vegetables, and several researches have shown that a significant proportion of a citys food requirements in developing countries are supplied from within the urban boundaries, because within those areas, substantial amount of waste water mainly from houses and industries, is available in urban drains for irrigating lands along the urban drainage courses [6].

Amaranth (*Amaranthus cruentus*) and Lettuce (*Lactuca sativa*) are produced along River Jakara which is used for the irrigation of vegetables and fruits which are consumed by the inhabitants of the area and the environs. It receives untreated metropolitan water through networks of drainages system. Urban waste water contains large quantities of nutrients such as nitrogen and phosphorus [7], [8]; and recent report [9] indicated that exotic vegetables production generates higher profits, generates more employment and income to the farmers than those indigenous vegetables. Some researchers are concerned more with the quality of the water and the soil and the subsequent health implications to the consumers and often recommend the stoppage of vegetable production along this route, paying no attention to the income and employment generated in the area.

It is against this background that this paper aims at describing some socio-economic characteristics of the Amaranth and Lettuce producers, determine the profitability of their production, determine the resource-use efficiency of their production and describe the problems they face along metropolitan Jakara river in Kano, Nigeria. The results may make those researchers mentioned earlier to have a change in their recommendations'.

II. METHODOLOGY

The study was conducted in three Metropolitan Local Governments of Kano, Nigeria, which record the highest intensity of Amaranth and Lettuce production along Jakara River, comprising of Fagge, Nassarawa and Ungogo. The population of these Local Governments estimated using the annual growth rate of 3.3% provided by National Population Commission [10] was put at 2,335,848 people by the year 2013. Kano metropolis covers an area of 499 Km^2 lying within latitude 110 58'37"N to 120 05'26"N and longitude 8029'48"E and 8033'45"E [11]. Majority of the inhabitants are traders, with civil servants, transporters and those engaged in vegetable crops production, poultry, seedling production and land developers. A large number of people within the metropolitan area are engaged in marketing of agricultural foodstuff, including vegetables [12].

Three (3) production sites each from these Local Government Areas were selected due to intensity of Amaranth and Lettuce production. These areas include Kwakwachi, Nomansland and Jaba from Fagge; Gama Kwari, PRP and Kwarin Ganga from Nassarawa and Gayawa, Rimaye and Dankunkuru from Ungoggo. The lists of registered Vegetable Crop Producers Associations in these areas were collected from Apex Fadama Users Association through the Departments of Agriculture and Natural Resources of these Local Government Areas. These lists served as sampling frame for the selection of the Amaranth and Lettuce producers. A Random sampling technique, using the random number generated using Microsoft Excel worksheet was used to select 180 Lettuce producers representing 9.5% of 1,897 members in the list. Data for the study were generated through the use of questionnaire administered to the selected Amaranth and Lettuce producers. Data collected include information on the socio-economic variables such as age, household size, level of education, years of experience and income level of the Amaranth and Lettuce producers; and costs of variable and fixed inputs, returns, inputs, outputs and problems facing Amaranth and Lettuce production. Net farm income and financial ratios such as return to naira invested, gross ratio, operating ratio and regression were computed. Descriptive statistics were also used in the study. The relations for the computations were given as

$$CV = \frac{SD}{mean} \times 100 \tag{1}$$

$$NFI = GFITC \tag{2}$$

$$RNI = \frac{TFI}{TC} \tag{3}$$

$$GR = \frac{TC}{TR} \tag{4}$$

$$OR = \frac{TVC}{TR} \tag{5}$$

Where: CV = coefficient of variability

SD = Standard deviation of the socio-economic characteristic in question.

Mean = mean value of the socio-economic characteristic in question.

NFI = Net Farm Income (₦/ha/year) for Amaranth or Lettuce production.

GFI = Gross Farm Income (₦/ha/year) for Amaranth or Lettuce production.

TC = Total Cost (₦/ha/year) for Amaranth or Lettuce production.

RNI = Return to Naira (capital) invested for Amaranth or Lettuce production.

TFI = Total Farm Income (₦/ha/year) for Amaranth or Lettuce production.

TC = Total cost (₦/ha/year) of Amaranth or Lettuce production.

GR = Gross Ratio for Amaranth or Lettuce production.

TC = Total Cost (₦/ha/year) for Amaranth or Lettuce production.

OR = Operating Ratio for Amaranth or Lettuce production.

TVC = Total Variable Cost (₦/ha/year) for Amaranth or Lettuce production.

TR = Total Revenue (₦/ha/year) for Amaranth or Lettuce production.

The multiple regressions for the production of Amaranth and Lettuce were specified as:

$$Y = f(X1, X2, X3, X4, X5, X6, X7, e) \quad (6)$$

Where:

Y = Quantity of Amaranth or Lettuce (Kg).

X1 = Farm size (ha) for Amaranth or Lettuce.

X2 = Hired labour (man/day) for Amaranth or Lettuce.

X3 = Quantity of seed (Kg) for Amaranth or Lettuce.

X4 = Amount of inorganic fertilizer (Kg) for Amaranth or Lettuce.

X5 = Insecticide (liter) for Amaranth or Lettuce.

X6 = Quantity of irrigation water (liter) for Amaranth or Lettuce.

X7 = Quantity of fuel used (liter) for Amaranth or Lettuce.

e = Error term

f = Functional notation

The specified multiple regressions for producing Amaranth and Lettuce were tried using the functional forms of linear, exponential, semi-log and Cobb-Douglas. The functional form which gave the best fit in terms of R^2 value, the number of significant independent variables, the appropriateness of the signs on the parameter estimates, *t*-values, *F*-ratio and the theoretical apriori expectations were selected as the lead equation, upon which further analyses were based. The model that fitted Amaranth production was the exponential while double-log fitted lettuce, based on the criteria stated earlier.

The efficiency of the resource-use was obtained at a point where the ratio (*r*) of *MVP* to *MFC* equals to one (1). That was:

$$r = MVP/MFC = 1 \quad (7)$$

where *r* is greater than 1, then the input, such as farm size, labour, seed, fertilizer, pesticide, water and fuel, was under-utilised, while if *r* was less than 1, then the input was over-utilized, all other variable inputs held constant.

The absolute value of the required adjustment needed in *MVP* to attain efficiency in resource allocation (D_i), as expressed by [13] was determined using the relation:

$$D_i = 1 - (1/ri)100\% \quad (8)$$

Where:

D_i= Absolute value of required adjustment for *MVP* to attain efficiency.

r_i = Ratio of *MVP* to *MFC* of each variable resource.

III. RESULTS AND DISCUSSION

The socio-economic variables identified include the age, household size, level of education, years of experience and income level of the Amaranth and Lettuce producers. These variables are presented in Table 1. Younger and middle aged individuals are known to be active and innovative [9]. The results of the study in Table 1 revealed that Amaranth and Lettuce producers had minimum and maximum ages of 18 to 67 years respectively with a mean of 38 years, indicating that the producers fall within the active age capable of undertaking all the mental and physical activities needed for producing the crops. Furthermore, they fall within the age that would enhance accurate, prompt and effective decision making. They are also expected to be in the position to effectively utilize available resources to them [14]. The results in Table 1 revealed that the household size of Amaranth and Lettuce producers ranged from 1 to 19 with a mean of 7 individuals which was beyond the national average of 5 reported by [15]. High number of household size could be due to the fact that Amaranth and Lettuce producers in the study area practice polygamy and having large household size is a source of pride and a compelling force to produce more output by the household head in the farms.

TABLE 1
AGE, HOUSEHOLD SIZE, YEARS OF EDUCATION, YEARS OF EXPERIENCE AND INCOME LEVEL OF PRODUCERS

Variable	Min.	Max.	Mean	*SD*	*CV* (%)
Age	18	67	37.45	10.95	29
Household Size	1	19	7	3.84	55
Years of Education	0	15	5.4	4.61	85
Years of Experience	1	48	18.57	10.41	56
Income Level/annum	268,710	1,636,570	460,567	350,315	76

Source: Field survey, 2013

The educational status of the Amaranth and Lettuce producers allows them to easily understand and apply new practices, objects and techniques in the production processes. The higher the level of ones education, the faster the rate of apprehension and application of an innovation. The results in Table 1 indicated that the formal educational attainment of Amaranth and Lettuce producers ranged from minimum of 0 to maximum of 15. The mean of their educational attainment was 5 indicating that the level of formal education attainment of the producers was low, then definitely they might not apply and utilize new technologies properly. They may so much rely on the local or indigenous education for the production of these enterprise. Recently, [16] got average years of education of 7 among irrigated vegetable producers in Imo State, Nigeria.

Years of experience refers to the period over which the Amaranth and Lettuce producer spends in the production of the enterprise. Expectedly, the longer the years of experience, the more the producer acquires managerial skills and subsequently improves on the efficiency of production. The results in Table 1 revealed that the years of experience of the producers ranged between 1 and 48 years with an average of 19 years. implying that some of the producers have relatively high years of experience. Ideally, they are expected to adjust to changing economic conditions and adopt new ideas to warrant efficient activity. Income level refers to the amount of money obtained from Amaranth and Lettuce production in a year. The results in Table 1 revealed that the producers recorded a minimum and maximum level of income of ₦268,710 and ₦1,636,570, with an average of ₦460,567. The average income of ₦460,567 was quite greater than the values obtained by [17] and [18] who got lower amount among farming households in rural ₦igeria of ₦30,245 and ₦35,000 respectively.

A. Profitability of Amaranth and Lettuce Production

Amaranth and Lettuce utilize virtually similar variable and fixed cost items. The costs, returns and profitability ratios of Amaranth and Lettuce are presented in Table 2.

The Total Cost (TC) of production sums up the Total Variable Cost (TVC) and the Total Fixed Cost. (TFC). It could be deduced from Table 2 that total variable cost amounted to ₦255,432 and ₦312,227 per hectare per year, covering 85 and 87 percent of the total cost of producing Amaranth and Lettuce respectively. It could be portrayed here that total variable cost covers major amount of total cost in the production of the two crops. The total fixed cost of ₦44,582 and ₦45,422 accounting for 15% and 13% for Amaranth and Lettuce were relatively large and could not be neglected. The Total Costs of producing Amaranth and Lettuce were respectively ₦300,015 and ₦357,649 per hectare per year. The variation in the total cost could be seen from the differences observed earlier on the amount of Variable Cost items.

Total Revenues in the production Amaranth and Lettuce of were obtained from the average output of 30,594 and 25,075 kilograms of the crops obtained per hectare per year respectively. Prices of these products were obtained for different periods and their arithmetic means were determined. The total revenues obtained were ₦513,979 and ₦651,936 per hectare per year for Amaranth and Lettuce respectively.

TABLE 2
COSTS AND RETURNS STRUCTURE FOR AMARANTH AND LETTUCE (₦/HA/YR).

	Amaranth					Lettuce				
Items	Average Item	Unit Price (₦)	Amount (₦)	*%TVC/ TFC*	*%TC*	Average Item	Unit Price (₦)	Amount (₦)	*%TVC/ TFC*	*%TC*
Variable cost										
Labour (Manday)	214.80	800 171,	840.00	67.27	57.28	265.29	800	212, 232.00	67.97	59.34
Seed (kg)	70.52	300	21,156.00	8,28	7.05	40.35	600	24,210.00	7.75	6.77
Fertilizer (kg)	81.66	130	10,615.80	4.16	3.54	86.25	130	11,212.50	3.59	3.14
Pesticide (ltr)	21.02	1,000	21,020.00	8.23	7.01	17.24	1,000	17,240.00	5.52	4.82
Fuel (ltr.)	250.16	103	25,766.48	10.09	8.59	380.37	103	39,178.11	12.55	10.95
Lubricant (ltr.)	8.39	600	5,034.00	1.97	1.69	13.59	600	8,154.00	2.61	2.28
Total Variable cost			255,432.28	100	85.15			312,226.61	100	87.30
Fixed cost										
Depreciation Pump			17,168.00	38.51	5.72			17,168.00	, 37.88	4.80
water hose			2,100,00	4.71	0.70			2,940,00	6.50	0.82
Sprayers			1,750.00	3.93	0.58			1,750.00	3.90	0.49
Seed containers			583.00	1.31	0.19			583.00	1.28	0.16
Hoe, sickles/ knives			1,667.00	3.74	0.56			1,667.00	3.67	0.47
Rent			21,314.17	47.81	7.16			21,314.17	46.93	5.96
Total fixed cost			44,582.17	100	14.85			45,422.17	100	12.70
Total cost			300,014.45		100			357,648.78		100
Total revenue	30,594	16.80	513,979.20			25,074.47	26.00	651,936.22		
NFI			213,964.75					294,287.44		
RNI			0.71					0.82		
GR			0.58					0.55		
OR			0.50					0.48		

Source: Field survey, 2013

The profitability measures such as the *NFI*, *RNI*, *GR* and *OR* were determined and presented in Table 2. The results indicated that the Amaranth and Lettuce producers realized a Net Farm Income of ₦213,965 and ₦294,287 per hectare per year for the production of the two crops respectively. Impliedly, Amaranth and Lettuce have positive *NFI* and therefore production of the two crops was profitable. [19] and [20] have earlier reported that production of Amaranth and Lettuce were profitable. The *RNI* of 0.71 and 0.82 for Amaranth and Lettuce implies that for every one naira expended by the producers, ₦0.71 and ₦0.82 would return to the investment of the Amaranth and Lettuce respectively.

The result further revealed *GR* of 0.58 and 0.55 for Amaranth and Lettuce production. The ratios with respect to the crops were all less than unity. A less than one ratio is preferred for any farm business. Impliedly, Lettuce recorded lower Gross Ratio than Amaranth indicating that Lettuce was more profitable than the Amaranth among their producers in the study area. In similar vein, the OR of Amaranth and Lettuce production were obtained as 0.50 and 0.48 respectively. Operating ratios of both crops were lower than unity. [21] also posited that a ratio less than one indicates that the producers are making profit.

B. Regression Results for Amaranth and Lettuce Production

The regression results in Table 3 reveals that the coefficient of multiple determination (R^2) values were 0.786 and 0.782 for Amaranth and Lettuce production in the study area. This implies that about 78% of the variation in the output of Amaranth and Lettuce were explained by the explanatory variables included in the models. These variables were farm size, labour, seed, fertilizer, pesticide, water and fuel. The remaining 22% not explained by the explanatory variables could be attributed to the error or random disturbance in the model. Similarly, the F-values of 90.197 and 87.96 were significant at 1% for both Amaranth and Lettuce, and they measure the overall or joint significance of the variable inputs included in the respective models. Impliedly, the variable inputs included in the models for Amaranth and Lettuce production had strongly explained the variations in the outputs of the two enterprises. The regression coefficients with respect to the intercepts for Amaranth (3.994) and Lettuce (4.642) were positive and significant at 1%, implying that 3.994 kilogrammes and 4.632 kilogrammes of Amaranth and Lettuce respectively could be produced without the commitment of the variable inputs considered in the study.

The regression coefficients with respect to farm size were 0.638 and 0.919; both positive and significant at 1% level for Amaranth and Lettuce respectively labour (-4.622E-12 and 0.011 for Amaranth and Lettuce and not significant for both crops), seed (1.024E-03 and 0.013 but both not significant for Amaranth and Lettuce respectively (inorganic fertilizer were -0.75 and 0.02 for Amaranth and Lettuce respectively both were not significant), insecticide (-0.11 and 0.206 for Amaranth and Lettuce production respectively), irrigation water (-2.085E08 and -0.076 respectively, both were significant at 5% level) and fuel (-0.002 and -0.058 for Amaranth and Lettuce respectively). Impliedly, increasing the supply of any positively signed coefficient by one unit would increase Amaranth and Lettuce production by the amount of the coefficient of the input in question, while for a negatively signed coefficient, reduction to the amount would result, holding all the other factors constant, all things being equal.

Evaluation of Resource-Use Efficiency of Amaranth and Lettuce Production The results in Table 4 revealed that all the variables included in the study such as farm size, labour, seed, inorganic fertilizer, insecticide, irrigation water and fuel for the production of Amaranth and Lettuce were inefficiently utilized, based on the *MVP/MFC* ratio criterion, because there was no variable whose *MVP/MFC* ratio was equating to unity. Farm size had an *MVP/MFC* ratio greater than one. Impliedly farm size was found to be under-utilized and needed to be increased. Though increasing land resource could not be advocated but its productivity could increase with the proper supply of inputs and controlling erosion. Labour, seed, inorganic fertilizer, insecticide, irrigation water and fuel were over-utilized for having an *MVP/MFC* less than one, implying that their application needs to be reduced for attaining efficiency.

The absolute value for the required adjustments in the *MVP* for attaining efficiency in Amaranth and Lettuce production were given as D_i against each resource respectively. The D_i's with respect to the resources for Amaranth ranged from 75% to 223%, while that of Lettuce ranged from 91% to 4,900%.

TABLE 3
REGRESSION RESULTS FOR AMARANTH AND LETTUCE PRODUCTION

	Amaranth			Lettuce		
Variable	Regression Co-efficient	*t*-value	*p*-value	Regression Co-efficient	*t*-value	*p*-value
Constant (a)	3.994	159.76	0.000***	4.642	12.859	0.000***
	(0.025)			(0.361)		
X1 (Farm size) ha	0.638	10.929	0.000***	0.919	8.133	0.000***
	(0.052)			(0.113)		
X2 (Labour)Man/day	-4.622E-12	-1.051	0.295	0.011	0.176	0.860
	(2.275E08)			(0.061)		
X3 (Seed)kg	1.024E-03	0.677	0.307	0.013	0.237	0.811
	(0.001)			(0.052)		
X4 (Fertilizer) kg	-0.75	-1.497	0.317	0.020	0.488	0.619
	(0.050)			(0.041)		
X5 (Insecticide) ltr.	-0.11	-0.175	0.131	0.206	3.583	0.000***
	(0.63)			(0.057)		
X6 (Water) ltr.	-2.085E-08	-3.26	0.001**	-0.076	-2.235	0.003**
	(6.39E-09)			(0.034)		
X7 (Fuel) ltr.	-0.002	-2.050	0.042*	-0.058	-0.967	0.335
	(0.001)			(0.060)		
R^2 =	0.786	0.782				
R^2 adjusted =	0.777	0.773				
F =	90.197***	87.964***				

Values in parentheses are the standard errors of the regression co-efficients. *** = ($p < 0.01$), ** = ($p < 0.05$), * = ($p < 0.1$) and ns = Not Significant. Source: Field survey, 2013

TABLE 4
EVALUATION OF RESOURCE-USE EFFICIENCY OF AMARANTH AND LETTUCE PRODUCTION

	Amaranth					Lettuce				
Variable	*MPP*	*MVP*	*MFC*	*R*	D_i	*MPP*	*MVP*	*MFC*	*R*	D_i
Farm size	4,353.90	85,205.82	21,314.17	4.00	75.00	8,858.56	253,089	21,314.17	11.87	91.58
Labour	-1.4E06	-2.74E05	800	-3.42E08	292.00	0.64	18.29	800	0.02	4,900
Seed	7.066	138.28	300	0.46	117.39	3.11	88.85	600	0.15	567
Fertilizer	-5,175	-101,274.75	130	-779.04	99.87	2.24	64.00	130	0.50	100
Insecticide	-759	-14,852.63	1,000	-14.85	93.27	115.50	3300	1,000	3.30	69.70
Water	-1.44E04	-0.0028	0.63	-0.0045	223.22	-7.37E05	-0.003	0.63	-0.003	334.33
Fuel	-14.15	-276.92	103	-2.67	137.00	-1.47	-42.00	103	-0.41	343.00

Note: *MPP* = Marginal Physical Product; *MVP* = Marginal Value Product; *MFC* = Marginal Factor Cost; D_i = Adjustment to *MVP* to attain efficiency. Source: Field Survey Data, 2013.

C. Threats of Amaranth and Lettuce production in the Study Area

Problems associated with Amaranth and Lettuce production identified during this study, presented in Table 5 were ranked and include unstable prices of the produce, inadequate farm size, soil erosion, inadequate loan and credit, pests and diseases attack and insufficient subsidy on the inputs.

The results in Table 5 revealed that all the producers of Amaranth and Lettuce (100%) in the study area suffered from problem of unstable prices of the produce. This is true when one looks at the sudden and rapid changes in the prices of these produce due to distortions caused by scarcity in their supply in the markets especially when the temperatures are relatively high; and during the rainy season.

TABLE 5
THREATS TO AMARANTH AND LETTUCE PRODUCTION

Threat	Frequency	Percentage
Unstable prices of the products	180	100.00*
Inadequate farm size	167	92.78*
Soil erosion	142	78.89*
Inadequate loan and credit	139	77.22*
Pests and diseases attack	134	74.44*
Insufficient subsidy on inputs	128	71.11*

* Multiple Responses Possible. Source: Field Survey Data, 2013.

IV. CONCLUSION AND RECOMMENDATIONS

This study determined the profitability and resource-use efficiency of Amaranth and Lettuce production along the dryland metropolitan Jakara River in Kano, Nigeria. The study showed that the producers realized profit as indicated by the values of the net farm income, return to Naira invested, gross ratio and the operating ratio despite the fact that all the resources used in the production of Amaranth and Lettuce were inefficiently utilized.

Threats to Amaranth and Lettuce production include unstable prices, inadequate farm size, soil erosion and inadequate loan and credit. By these results, the researchers in the water, soil and health should recommend that the water should be well treated by the industries around the water route under the government surveillance, and farmers continue their production activities'. The study therefore recommends that the Governments at Local and State levels should put machineries such as the use of media, for enlightening the producers on the need for effective utilization of inputs needed for the production of Amaranth and Lettuce such as seeds, fertilizers, fuel, water pumping machines and insecticides to enhance the profit realized; and assist in the control of soil erosion; and the producers should access loans and credit from public and private lending institutions through their associations to boost their capital base.

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