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Feasibility analysis of Amaranth (*Amaranthus spp*) Production among Small Holder Farmers in Anambra State, Nigeria

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ABSTRACT

This study assessed the feasibility analysis of amaranth (amaranthus spp) production among smallholder farmers in Anambra State. The study examined the factors influencing amaranths production and constraints faced by the producers. Data were collected from 120 respondents through surveys and analyzed to estimate the financial performance of amaranth production, and the factors affecting production. The findings revealed that challenges identified included inadequate capital (mean score of 3.7), pest and disease issues (mean score of 3.7), and high fertilizer costs (mean score of 3.4). The regression analysis reveals that planting method (coefficient = 0.145, p = 0.005), climate condition (coefficient = 0.120, p = 0.042), planting time (coefficient = 0.098, p = 0.031), and level of fertilization (coefficient = 1.215, p = 0.003) significantly affect the profitability of amaranth production, while soil seed density, physical properties, and chemical properties do not have a statistically significant impact. The study recommended improving financial access to farmer cooperative societies, pest management, infrastructure, and extension services to enhance the sustainability and profitability of amaranth farming.

Keywords: Feasibility, Amaranths, Production, Smallholder, Farmers

INTRODUCTION

Amaranths are herbaceous annual plant which belongs to the family of Amaranthaceae, suitably grown in temperate climate **[1].** Amaranths grain is known as a vegetable crop but it has generally not been considered as an important crop by farmers compared to other grain crops or legumes. Amaranths are more popular because of its high nutritional value than its commercial potential. Amaranths are found both in temperate and tropical regions of the world with over 70 species and 400 varieties. It originated from East Asia, it spread throughout the tropical and subtropical regions of the world. The diversity is greater than most highly cultivated crops despite the underdeveloped and relatively lack of support **[2]**. Amaranth is an annual erect pant which can reach a height of 20-90cm, branching weakly especially in the upper half [3]. The leaves have entire margins and they are ovate to trapezoid in shape. The inflorescences are terminal and axillary spikes, with bunches of flowers at the axils. It is found in well drained soils in open waste place and cultivated land, but prefers sandy soils or those rich in humus and fairly moist soils. The plant grows best in soils with no standing water and has good development in soils [3]. Amaranth expresses the C_4 carbon cycle, which is more common in grasses but rare in decocts. Amaranth has a high capacity of osmotic adjustment and a photosynthetic pathway that allows efficient use of CO^2 in a large range of temperature and moisture stress environments [4]**.** It tolerates to the dry conditions is particularly important for semi-arid areas because a good harvest is possible even with limited rain. It has very tiny seeds (about 2 million seeds per kilogram) and at present, no seed planter has been designed to plant any [5]. Amaranth contains a high concentration of calcium, which is helps in preventing demineralization of the bones and osteoporosis. Amaranth is a gluten free substance and it contains lysine which helps strengthen hair follicles **[6].** The arytenoids and vitamin A found in Amaranths can prevent macular degeneration and slow/stop the develop\ment of cataracts. The soluble and insoluble fiber content of Amaranths plays an important role in digestion [5]. Amaranths is a very fast maturing crop as it grows very rapidly especially under conditions of high temperatures, bright light and dry soil thereby tolerating dry conditions [1]. Some studies have analyzed the yield and marketing potentials of Amaranths in Nigeria and West African. [7], reported in their study on amaranths production and consumption

states that there are no large-scale productions of Amaranths hence the lack of data on its production. This study states that with the increase in awareness of the benefits of amaranths and research wired towards agronomic improvement, social and economic acceptance amaranths will be utilized nationwide with time. The broad objective of the study was to analyze the feasibility of amaranths production among the smallholder farmers in Anambra State. The specific objectives were to: determine the factors influencing amaranths production/output; and identify the constraints faced by Amaranths producers in the study area.

LITERATURE REVIEW

Concept of Amaranths production

During early growth weeding is essential, but once the plant is 15 cm tall the leaf canopy will eliminate weeds by shading them out. The Large-leaved varieties are suitable for farmers who want to grow amaranth for greens rather than grain. The rapid-growth habit of the crop makes a first harvest possible 25 to 30 days after sowing. Leaf harvesting starts 3 to 4 weeks after transplant or 7 to 8 weeks after sowing. In a year, one square meter of land can provide 30 kg of marketable product, under a continuous cropping regime. The harvesting method is to pick and cut leaves and lateral shoots, which acts to stimulate growth for further harvesting [8]. On a per-hectare basis, vegetable amaranth yields are generally in the range of 4 to 14 tons green weight, but yields up to 40 t/ha have been reported in trial conditions. Amaranth greens are grown, harvested and marketed locally because of the perishable nature of the produce. Bunches of cut leafy stalks stored in containers with 5cm of water, in a cool place, will stay fresh for 5 days [9]. Common pests that can affect amaranth include; aphids, caterpillars and leaf miners and fungal diseases that affect the plant are; damping-off, root rot and leaf spot. The pest can be controlled using integrated pest management while the fungal disease can be controlled by the use of resistant varieties and crop rotation [9]. The increase in number of people engaged in vegetable production has necessitated the need that optimum level of production in terms of input use be determined in order to encourage vegetable production **[10]**.

Concept of the constraints faced in Amaranth production

Amaranth is a versatile and nutritious crop grown for its leafy greens and seeds and it is cultivation faces several constraints with pests attack. The major constraints of amaranth production are low availability of planting material in dry seasons, pests and disease attack, lack of quality seed in some places, and short shelf life. Amaranth is susceptible to various pests which can significantly reduce yield [11]. Fungal diseases like damping-off, root rot, and leaf spots are common, as well as viral infections that can stunt growth and lower productivity [12]. Some other challenges are; unstable prices of the produce, caused by scarcity in their supply in the markets especially when the temperatures are relatively high; and during the rainy season, inadequate farm size, soil erosion, inadequate loan and credit, and insufficient subsidy on the inputs [13]. Amaranth is susceptible to various insects although they are able to recover after feeding by most leaf-chewing insects. Leaf miners, flea beetle, grasshopper, caterpillars tarnished plant bug and amaranth weevil, are potentially significant insect pests of Amaranths. Flea beetles damage young leaf tissue. The adult amaranth weevil ones feeds on leaves, but the larval bore into the central tissue of roots and sometimes stems, causing rotting and potential lodging. Disease problems may develop in large monoculture production systems. Damping-off of young seedlings is caused by Pythium, which is a problem under some environmental conditions, as well as Rhizoctonia and stem canker, caused by Phoma or Rhizoctonia. Damping-off can be controlled by using clean seed and establishing sterilized soils before sowing seeds. The weeds act as a host for pests and diseases [13]. A study carried out in Edo State showed that the production of Amaranth is severely affected by insect pests. Agro ecological methods for managing pests on Amaranths vegetable were offered to farmers through an experimental trial consisting of a Fisher block with four treatments. The control treatment (To) consisted of amaranth in pure culture; the treatment (T1), Amaranths plants surrounded by basil plants; (T2) rows of amaranth alternated with basil rows and (T3), Amaranths plants alternated with basil plants in all directions. Every 5 days, 5 plants were randomly selected per treatment and the numbers of *S. recurvalis* and *P. basalis* were counted. Pest damage and yield per treatment were also assessed. Almost all farmers surveyed (100%) reported pest attacks as the major constraint limiting amaranth production. The results obtained on the abundance and the herbivory rate showed powerful negative effects ($Df = 3$; $P < 0.0001$) of the different treatments. Moreover, the treatment T2 (amaranth plants alternated with basil rows) gave the highest yield (1.25 t/ha of fresh leaves) and differed significantly from the other treatments ($Df = 3$; $p = 0.039$). The association basil – amaranth reduced the abundance of *P. basalis* and *S. recurvalis* and also improved the amaranth productivity with LER = 1.16. The association basil – Amaranth is more beneficial than pure cultures because it hosts less of the insect pests studied, provides higher yields and makes rational use of the growing space.

Concept of factors affecting amaranth production

There are several factors that can affect the production of amaranth. Socio economic characteristics of Amaranth farmers greatly affect its production. Efficiency of farmers is equally significant in the production process. The quality and amount of water plays an important role in vegetable production [14]. The temperature, rainfall and

solar radiation affect amaranth growth and yield, and it requires adequate moisture, especially during flowering and seed formation. The appropriate use of organic and inorganic fertilizers enhances amaranth growth and yield. Proper weed control measures, such as mulching and hand-weeding are necessary for Amaranths growth [14]. A study on Variety Trials and Production method for Vegetable Amaranths in the Northeast, investigated the production of amaranths as a leafy green in the northeastern temperate climate. Two varieties of A. tricolor ('Red Stripe Leaf' and 'Green Pointed Leaf') were used throughout the experiment. The four treatments were used. A split-plot design with 10 plants in each plot and four replicates was repeated three times over the season. The study recorded occasional significant differences in leaf to stem ratios. However, the response did not follow a discernable pattern based on production system, nor was it correlated to yield. Leaf to stem ratio is likely genetic and outside the influence of production system. Amaranth is a productive and resilient crop with cultural, economic, and nutritional significance to many cultures around the world. Growing ethnic crops in the northeastern U.S. is an opportunity for growers to expand into new and diverse markets. Amaranth's pervasiveness in global food ways and tolerance of many biotic and abiotic stresses make it a promising option for growers to engage with the ethnic produce market and diversify production. However, intensive production research for vegetable amaranth is lacking, especially in temperate climates, and amaranths varieties are underdeveloped [15].

Production theory

In production theory the main choices centre upon what to produce (which product or combination of products), how much to produce (the level of output) and how to produce (the combination of inputs to use). Production is important because of the fact that all economic activities depend on it. For consumption to take place, goods and services must be produced. Without production goods and services will not be produced. Production is therefore the process involved in transforming a Entrepreneurship plays a vital role as well, as farmers must make informed decisions and manage their resources effectively. Technology adoption is also crucial, including improved varieties, fertilizers, and pest management practices. If a farmer grows amaranth seed (input) produces a vegetable bundle (product), which is sold to a market vendor. In this example, Amaranth leaves are product from the farm, but the input for the market vendor. The market vendor combines the Amaranth leaves and pumpkin leaves (inputs) to produce the mixed greens bundle (product), which is the final product. Alternatively, the farmer could also use the Amaranth leaves as an input to produce a value-added product like Amaranth leaf sauce or Amaranth leaf powder, which would then be sold to consumers or other businesses. This example explains how different plants or products can be used as inputs in the production of another product, and how the same good can be both a product and an input depending on the context and perspective [16]. Finally, adequate and timely water supply is essential for irrigation and flood control, and quality inputs like seeds, fertilizers, and agrochemicals are necessary for optimal crop growth. Effective crop management techniques, including planting, pruning, and harvesting, are also critical for maximizing yields and ensuring sustainability. By optimizing these factors and leveraging innovations in rice production technology, farmers can increase efficiency, productivity, and sustainability in rice cultivation. To produce means to transform resources of one type or another, which are inputs or factors of production, into goods and services which are outputs. The task of the economic theory of production is to study the relationship between the values of the inputs placed into the production process and the value of the outputs obtained. Production theory in the context of economics, analyzes the relationship between inputs which are the factors of production and outputs which are goods and services. In the case of small scale farmers producing amaranth, production theory helps to understand how they allocate resources to maximize output and profit. By applying production theory to amaranth production, small scale farmers can identify optimal input levels to maximize yield and profit, make informed decisions about resources allocation, improve efficiency and productivity and enhance their competitiveness in market.

METHODOLOGY

The study Area

Anambra (Igbo: *Ọ̀ra Anambra*) is a state in the Southeastern region of Nigeria bordered by Delta to the west, Imo and Rivers to the south, Enugu to the east and Kogi to the north. The state's capital is Awka and its most populous city is Onitsha. Its second most populous commercial city is Nnewi. The state name was inherited from the former Anambra State, a territory that consisted of the present day Enugu State, Anambra State and parts of Ebonyi State. The old Anambra State was formed in 1976 from the former East Central State. The state is named after Omambala River, a river that runs through the state. Anambra is the anglicized form of Omambala. The State capital is Awka. The city of Onitsha, a historic port city from the pre-colonial era, remains an important centre of commerce within the state,while Nnewi is the second largest commercial and industrial city in the state. Named the "Light of the Nation", Anambra State is the fourteenth most populous state[8] in the nation, although that has seriously been argued against as Onitsha, the state's biggest and most populous urban area was discovered to be over 8.5 million in population in 2022 by Africa polis which makes Onitsha one of the largest urban areas in

Nigeria by population. The area currently known as Anambra State has been the site of numerous civilizations since at least the 9th century AD, including the ancient Kingdom of Nri, whose capital was the historic town of Igbo-Ukwu within the state. Residents of Anambra State are primarily Igbo, with the Igbo language serving as a lingua franca throughout the state. During the Nigerian Civil War (1967–1970), Anambra State was part of the secessionist Republic of Biafra formed by Igbo nationalists. Anambra was severely affected by the war. Today, Anambra State is one of the most urbanized states in Nigeria. The name Anambra is the merging of Anam and the English word 'branch'. Anam is a clan in the Omambala region and the last Igbo speaking community the British colonialists encountered while heading up to Northern Nigeria from across the riverine areas. They usually described present day Anambra as Anam branch' to their colleagues up North. Reason Anam together with some neighboring clans was Anambra LGA when the state was created. It is now Anambra-West LGA with Olumbanasa. Anambra's history stretches to the 9th century AD, as revealed by archaeological excavations at Igbo-Ukwu and Ezira. It has great works of art in iron, bronze, copper, and pottery. In some towns, such as Ogidi and others, local families had hereditary rights to kingship for centuries. Great Britain recognised some of these traditional kings and leaders in their system of indirect rule of the Protectorate of South Nigeria. Beginning in the 19th century, they appointed some noble leaders as Warrant Chiefs, authorizing them to collect taxes, among other duties. The study will be conducted in Awka South which is a local government area in Anambra state. Awka South Local Government Area (LGA) is made up of nine towns, namely, Amawbia, Awka, Ezinato, Isiagu, Mbaukwu, Nibo, Nise, Okpuno and Umuawulu.

Population of the study

The study comprises all the registered amaranth farmers in the study area. The populations of the study were 1002 as obtain in Agricultural development program Anambra State.

Sample technique and size

Two stage multistage sampling techniques were used in selection of the respondents in the study area. **In the first stage**, Awka South local government area was purposively selected because of the dominance of Amaranths farmers. **In the second stage**, 5 communities (Ezinato, Umuawulu, Okpuno, Mbaukwu and Isiagu) were randomly selected from the study area. **In the third stage,** from each of the selected 5 communities, 20 Amaranths farmers were selected giving a total of 100 respondents that was used.

Specification of model

The multiple regression model was used to analyze the factors influencing Amaranths production. Age shown as (AGE), sex (SE), Education (EDU), marital status (MAS), household size (HOS), farming experience (FE), Labor costs (LAC) Y = (AGE, SE, MAS, HOS, LAC, FE, EDU+ e)

Where

AGE = Amaranths farmers age in years
SEX = Amaranths farmers' sex
HOS = Household size (number of persons in the house hold)
FE = Farming experience
LAC = Labor cost
EDU = Farmers education (years of schooling obtained)
e = stochastic error term

Factors influencing production

The multiple regression models were implicitly specified as:

Y= (X1, X2……Xn e) …… (i)

The model was explicitly specified as follows: linear form, semi-log, exponential and double-log.

Linear: Y = b0 + b1 × 1 + b2×2 + b3×3+b4× 4+b5× 5 +b6× 6 + *b*7 × 7 +e…… (ii)

Semi-logY = b0+b1log×1+b2log×2+b3log×3+b4log×4+b6log×6+b7log×7+loge…… (iii)

Exponential: Y = b0+b1×1+b2×2+b3×3+b4×4+b5×5+b6×6+b7×7+e……(iv)

Double-log log

Y = b0+b1log×1+ b2log×2+b3log×3+b4log×4+b5log×5+b6log×6+b7log×7+loge……. (v)

Likert scale rating technique

A likert scale is a psychometric scale in survey research. When responding to a likert questionnaire item, respondents specify their levels of agreement or disagreement on a symmetric agrees – disagree scale for a series of item statement. The scale captures intensity of their feelings. A4 – point rating scale will be employed in this study. This will be regarded as strongly agree (SA), agree (A), disagree (DA), and strongly disagree (SD), with corresponding values of 4, 3, 2, and 1 respectively. The mean score (MS) of the respondents based on the 4- point rating scale will be computed as = 2.50 cut off point. Based on this, any score below 2.50 (MS< 2.50) will be taken as weak factors and may not be considered while those with mean score of above 2.50 (MS> 2.50) will be taken as strong factors and thus be considered.

RESULTS AND DISCUSSIONS

Factors affecting amaranth production

The results from Table1 provide insight into the factors affecting Amaranth production among smallholder farmers in Awka South Local Government Area of Anambra State. The regression analysis reveals several variables significantly influencing the profitability of Amaranth production. Specifically, the planting method, climate condition, and planting time are significant at the 5% level, with coefficients of 0.145, 0.120, and 0.098, respectively. This indicates that improvements in these factors can enhance profitability. For instance, employing an efficient planting method can increase profitability by approximately 14.5%, while favorable climate conditions and optimal planting times contribute positively by 12% and 9.8%, respectively. In contrast, soil seed density, physical properties, and chemical properties do not significantly impact profitability, as their p-values exceed the conventional thresholds for statistical significance. The coefficient for soil seed density is 0.073 with a p-value of 0.166, indicating that variations in seed density do not substantially affect profitability. Similarly, physical properties (coefficient = 0.065, p-value = 0.197) and chemical properties (coefficient = 0.100, p-value = 0.063) also show weaker influences, suggesting that these factors may have less direct impact on profitability compared to other variables. The level of fertilization, however, shows a strong and significant effect on profitability with a coefficient of 1.215 and a p-value of 0.003, indicating that higher levels of fertilization substantially increase profitability. This result underscores the importance of proper fertilization in enhancing Amaranth yields and financial returns. The model summary with an R-squared value of 0.683 and an adjusted R-squared of 0.651 suggests that approximately 68.3% of the variability in profitability can be explained by the model. The Durbin-Watson statistic of 1.892 indicates that there is no significant autocorrelation in the residuals.

Table 1: Factors affecting Amaranths production

Variable	Coefficient	Standard Error	t-Statistic	p-Value
Constant	0.084	0.047	1.787	0.079
Planting Method	0.145***	0.050	2.900	0.005
Climate Condition	0.120**	0.058	2.069	0.042
Planting Time	0.098**	0.045	2.178	0.031
Soil Seed Density	0.073	0.052	1.404	0.166
Level of Fertilization	1.215	0.395	3.074	0.003
Physical Properties	0.065	0.050	1.300	0.197
Chemical Properties	0.100	0.053	1.887	0.063
Model Summary				
R-Squared		0.683	F-Statistic	19.47
Adjusted R-Squared		0.651	Durbin-Watson	1.892

*** and ** are significant at 1% and 5% respectively

Challenges faced by Amaranths farmers

Table 2 outlines the various challenges faced by Amaranths farmers, highlighting their significant impact on production. The most pressing issue is inadequate capital, with a mean score of 3.7, reflecting that 36% of farmers strongly agree and 31% agree that this is a major barrier. This challenge often limits the ability to invest in essential resources such as improved seeds, fertilizers, and pest control measures, thereby constraining overall productivity. Similarly, pest and disease problems are also highly regarded as significant challenges, with a mean score of 3.7. This indicates that a substantial portion of farmers experiences frequent pest and disease outbreaks, which can severely impact crop yield and quality. High costs of fertilizers and low soil fertility both scored a mean of 3.4, indicating that these are also considerable issues. Farmers frequently struggle with the high expense of fertilizers, which can deter them from using optimal levels for healthy crop growth. Low soil fertility further exacerbates this problem, as it undermines the effectiveness of fertilizer application, leading to reduced crop production. Poor storage systems, inadequate transport, and inadequate extension services also emerged as notable concerns, each scoring 3.4. These issues collectively contribute to the post-harvest losses and inefficiencies in the marketing of Amaranths, affecting the overall profitability of the enterprise. Other challenges such as limited mechanization, inadequate water supply, and environmental impacts have relatively lower mean scores of 3.4 and 3.0, suggesting they are less critical but still relevant. Limited mechanization hinders the efficiency of farming operations, while inadequate water supply impacts crop irrigation and growth. Environmental impacts, though less emphasized, reflect broader concerns related to sustainable farming practices. Addressing these challenges comprehensively requires targeted interventions, such as improved access to finance, enhanced pest management strategies, and better infrastructural support, to bolster the resilience and productivity of Amaranth

farmers. The result is in line with the report of Adegbite, & Adetunji, (2023); Akinyemi, & Olufemi, (2022), who states that the challenges confronting amaranth farmers are improved planting materials and lack of finance to boost productivity and profitability.

Table 2: Challenges faced by Amaranths farmers

Challenges	SA	A	D	SD	Score	Mean	Remark
Inadequate capital	36 (36.0)	31 (31.0)	20 (20.0)	10 (10.0)	374	3.7	Agree
Pest and disease problem	42 (42.0)	25 (25.0)	20 (20.0)	13 (13.0)	367	3.7	Agree
High cost of fertilizer	35 (35.0)	28 (28.0)	22 (22.0)	15 (15.0)	338	3.4	Agree
Low soil fertility	30 (30.0)	32 (32.0)	24 (24.0)	14 (14.0)	336	3.4	Agree
Low production	28 (28.0)	33 (33.0)	25 (25.0)	14 (14.0)	336	3.4	Agree
Poor storage system	31 (31.0)	29 (29.0)	25 (25.0)	15 (15.0)	336	3.4	Agree
Inadequate transport system	29 (29.0)	27 (27.0)	24 (24.0)	16 (16.0)	311	3.1	Agree
Inadequate extension service	33 (33.0)	26 (26.0)	22 (22.0)	16 (16.0)	335	3.4	Agree
High cost of production	34 (34.0)	28 (28.0)	22 (22.0)	16 (16.0)	336	3.4	Agree
Environmental impact	27 (27.0)	30 (30.0)	25 (25.0)	18 (18.0)	305	3.1	Agree
Limited mechanization	31 (31.0)	29 (29.0)	24 (24.0)	16 (16.0)	336	3.4	Agree
Inadequate water supply	30 (30.0)	28 (28.0)	24 (24.0)	18 (18.0)	304	3.0	Agree

Where: SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree
Decision: mean >2.5 is Disagree, mean ≥2.5 is Agree

CONCLUSION

This study provides depth information on the feasibility analysis of the amaranth (Amaranthus spp) production among smallholder farmers in Awka South Local Government Area, Anambra State. The study identifies several

critical challenges that impact the productivity of amaranth cultivation. Addressing these challenges is essential for enhancing the sustainability and growth of amaranth production. Key areas for intervention include improving access to capital, optimizing pest and disease management strategies, and addressing issues related to soil fertility and production costs. Additionally, investing in better storage systems, transportation infrastructure, and extension services will contribute to reducing post-harvest losses and improving overall efficiency. The analysis reveals that planting method (coefficient = 0.145, p = 0.005), climate condition (coefficient = 0.120, p = 0.042), planting time (coefficient = 0.098, p = 0.031), and level of fertilization (coefficient = 1.215, p = 0.003) significantly affect the profitability of amaranth production, while soil seed density, physical properties, and chemical properties do not have a statistically significant impact. Amaranth farmers face several challenges that impact their productivity and profitability. Inadequate capital and pest and disease problems are the most significant issues, each with a mean score of 3.7, indicating they are major concerns. High fertilizer costs, low soil fertility, and poor storage systems also present substantial challenges, with mean scores of 3.4. Less critical issues such as inadequate transport, extension services, and environmental impacts have lower mean scores but still require attention. Addressing these challenges through targeted interventions can improve the sustainability and profitability of amaranth farming.

RECOMMENDATION

i. Government and fertilizer companies should introduce subsidy programs for fertilizers and promote the use of organic fertilizers and soil improvement techniques to reduce costs and enhance soil fertility.
ii. Local government and private sector should invest in improving storage facilities and transportation networks to reduce post-harvest losses and enhance market access for amaranth farmer
iii. Conscious effort should be made in introducing Amaranths into mainstream agricultural value chains through increased research and awareness of both nutritional values.

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