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Farming Techniques, Environmental Challenges, and Technical Efficiency of Sweet Potato Production in Abia State, Nigeria

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Abstract

Viable sweet potato production is hard to achieve with indiscriminate use of farm inputs, resulting to wastage and environmental damages, as consequences are common problems of arable crop farming in Abia State. Issues arising from farm input use and their corresponding implications for environment called for a study on suitable farming practices and farm-specific technical efficiency for optimal resource use in sweet potato production in Abia State. Data were obtained from 156 sweet potatoe farmers through a multistage sampling technique using a structured questionaire. Data were analyzed using descriptive statistics such as mean, relative frequency distribution, and the stochastic production frontier. Results showed that using inorganic fertilizer (65.378%) under rainfed production system with a frequent bush burning (66.67%) and low liming (5.8%) were very common practices with leaching, fragile soil, erosion, flooding, and soil acidity as consequences. Mixed cropping (63.46%) with improved varieties like TIS 8164 (71.2%) and 0087 (64.1%) were copping measures to some environmental challenges. Maximum Likelihood Estimates (MLE) showed a decreasing return to a scale of 0.236. The implication is that an increase in farm size and fertilizer application can significantly lead to a less than 0.06538 and 0.08142 proportionate increase in output of sweet potato respectively, or reduces it by less than 0.00413, with interest on borrowed capital. The gamma (0.0403) was less than unity and was significant at $p < 0.05$, implying that about 4.30% discripancies in observed and frontier output was due to technical inefficiencies of sweet potato farmers. The wide disparity in farmers' technical efficiencies ranged from 0.298% to 99.4%, and a mean of 47.1% suggested a need to bridge the gap. Hence, a reduction in household size, farming experience, and sourcing of planting materials from NRCRI or IITA is believed to increase farmers' technical inefficiency, which can be reduced with age and formal educational level of sweet Potato farmers in the area. All in all, the results suggest that reducing bush burning but increasing liming as well as including organic soil ammendments and irrigation practicies, when combined with the use of young and educated farmers, can reduce environmental damages and also increase farmers' technical efficiency when it comes to sweet potato production in the area.

Keywords:
Environment, Technology, Efficiency, Sweet potato production, Stochastic Frontier, Abia State

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INTRODUCTION

Sweet potato (*Ipomoea batatas*) belongs to the family convolvulaceae (Woolfe, 1992). It is an important food crop of both tropical and sub-tropical regions with a cultivation spread across 100 countries (Nwaru, 2003). The crop has high photosynthetic efficiency (Kapinga et al., 1997), a high yielding capacity per unit area and ability to sustain human livelihood during periods of food shortage (Ndukwu, 2010). Farmers engage in massive production of this crop because of its short gestation period and its ability to suppress weeds once it has been fully established, thus reducing the overhead cost of production more than that incurred by cassava and yam (Woolfe, 1992).

Inadequate use of disease resistant varieties and high yielding sweet potato clones from National Root Crops Research Institute (NRCRI) and International Institute of Tropical Agriculture (IITA) could be a reason for low output in sweet potato production. The wide use of unimproved varieties such as *Cylas puncticollis* by farmers due to shortage of improved planting materials at the beginning of every cropping season could be a reason for the low output of sweet potatoes. Studies have shown that the Southeast states of Nigeria are yet to attain their full potential food security status using sweet potatoes, because farmers have not taken advantages of improved crop varieties to maximize output and profit (Njoku et al., 2009; Onwueme, 1978 & Tewe et al., 2001). Sweet potato production is characterized by crop failures due to the frequent use of low disease resistant varieties. There is 80% loss in sweet patotoe's output in Nigeria due to *Cylas puncticollis* (Tewe et al., 2001). This implies that the use of bad techniques in food production does not only place the farmers at a disadvantage of crop failure alone and a low output status but also a sever damage to the environment. A fundamental problem confronting mankind is how to meet an increasing demand for food and environmental services without compromising each other. An understanding of the web of relationships and linkages between the use of environment and agricultural productivity is, therefore, critical in meeting the future challenges.

The environment comprises natural resources in its physical, chemical, and biological forms, which humans and other living species depend on for their life support and social welfare (Hussein, 2004) while an increased standard of living and satisfaction of humans' wants are the attributes of agricultural productivity. The two natural variables challenge each other in trying to achieve their common goals. A change in climate affects farm productivity in particular and other socio-economic activities in the country. Aagriculture in Nigeria is mostly rain-fed and some common agricultural practices challenge the climate as more ozone layer is depleted. This in turn poses some major challenges to agricultural productivity. The impact of climate on farming activities could, however, be measured in terms of its effect on crop growth, low availability of soil water, increased soil erosion, incident of pest and diseases, sea level rises, and decrease in soil fertility (Adejuwon, 2004). There is always a serious challenge for farmers who concurrently seek to satisfy the food demand through increased output and retain the quality of natural stock and a balanced ecosystem (Ehirim, et al., 2013; Oldeman et al., 1991). Farmers lack the requisite piece of technology to manage their production and control the environment in such a way that food production will be sustainable (Ehirim, et al., 2013).

Farmers cropping pattern is associated with erosion and leaching, which reduces crop yield. For instance, the bush burning and felling of trees in the Southeast states seem to be the common and suitable choice for farmers but pose a major environmental challenge. Ehirim et al (2013) also noted that the common choice of livelihood strategies in Nigeria is patterned by the poor socio-economic disposition of farmers. Lack of awarness and skepticism of the workability of some improved soil management techniques as well as low income are reasons for most cropping patterns adopted by farmers in the Southeast states of Nigeria (Ogbonna et al., 2007). Low income makes the use of sustainable soil management technologies impossible in sweet patoto production in Nigeria. Again, the general lack of interest in sweet potato production was due to poor motivation from low returns per hectare. Farmers poor socio-economic dispositions are having overwhelming influence on their input mix decisions. Input-output process in arable crop production is important in four major areas like; the distribution of farmers income, allocation of farm input resources, the relation between stocks and flows, as well as the measurement of efficiency or productivity (Olayide & Heady, 1982). Therefore, an increasing rate of investment in agricultural production is corresponding to increasing rate of returns with a high production efficiency (Assa et al., 2012). Yet, farmers input mix decisions on sweet potatoe farming are not only negatively affecting their input-output processes and returns per hectare but also the environment, as productive efficiency is compromised in the long run.

Efficiency is described as the extent to which time, effort, or cost is well managed for an intended task or purpose. Aigner (1977) defined “efficiency” in three related terms: First, he defined “technical efficiency” as the measure of a firm’s success in producing maximum output from a given set of input. This implies that undisputed gain can be obtained from adequate input mix process by simply organizing management in a better pattern. Second, “price or allocative efficiency,” which measures a firm’s success in choosing an optimal set of input based on their relative prices. The gains are possible by varying the input ratios on certain assumptions about their future price structure. Third, is the “overall or economic efficiency,” which is simply the product of both technical and price efficiencies? Adequate input combination blended in skills, knowledge of choice of techniques and their interactions with the environment, as well as farming experience among other socio-economic factors influencing a famer’s life can set up effectiveness with which a given set of inputs can produce the optimum quantity that gradually brings farmers to the best practiced frontier without denaturing the environment (Ehirim, 2013). The ability to employ the best practices for increased output measures the farmers technical efficiency, but when it ensures a steady natural stock, the production process is potentially viable (Ehirim, 2013). Most empirical studies have demonstrated that farmers are grossly inefficient in the use of farming inputs to increase output and returns (Meeusen & Van-den Broeck 1977; Ndukwu, 2010 & Oni et al., 2009).

This study is centered on achieving an input mix process that can set up an optimal sweet potato production without denaturing the environment. It isolated the factors sweet potato production, as well as the effect of environmental consequencies of the choice of farming techniques on technical efficiency of sweet patoto production in Abia State. The study is set to place farmers on the right footing to reduction in waste of farm inputs use but attain a maximum output and reduction in food security in Imo State. Hence, a stable foundatiion is laid for optimal production, increase in returns and profit in sweet patoto production in Abia State.

In this study, the researchers consider only the stochastic frontier models based on the estimate of the frontier production function. In Greene’s (1997) words, "the frontier production function is an extension of the familiar regression model based on the microeconomic premise that a production function represents some sort of ideal, the maximum output attainable given a set of inputs" (Greene, 1997). In practice, the frontier production function is a regression where the estimation of the production function is implemented with the recognition of the theoretical constraint that all observations lie below it, and it is generally a means to another end, that is, the analysis of efficiency. A measure of efficiency emerges naturally after the computation of the frontier production function, since it corresponds to the distance between an observation and the empirical estimate of the theoretical ideal. The estimated models provide a means of comparing individual agents, either with the ideal production frontier or with each other, and also provide point estimates of the effects of environmental variables on efficiency (Francesco, 2009). This study therefore seeks to examine the contributions of suitable farming practices and farm specific technical efficiency to optimal resource use in sweet potato production in Abia State.

MATERIALS AND METHODS

The study was carried out in Abia State which is one of the 36 states in Nigeria. The State lies between longitude 040 45' and 060 07' North, and latitude 070 00' and 080 10' East. It is situated in the Southeast geo-political zone of Nigeria and is bounded by Imo State on the West, Ebonyi and Enugu States on the North, Cross Rivers and Akwa Ibom States on the East, and Rivers State on the South. The State has a total land area of 6320 square kilometres and a population size of 4,222, 476 persons (National Population Commission, 2007). The State is divided into three agricultural zones, namely Umuahia, Ohafia, and Aba Zones.

A multi-stage sampling procedure was employed in this study. In the first stage, of the three agricultural zones of the state, namelyAbia North, Abia South, and Abia Central, a purposive selection of three local government areas, each from an agricultural zone of the state, was made. The areas selected were predominantly sweet patoto producing areas that had also benefited from at least one of the improved sweet potato varieties from National Root Crop Research Institute Umudike. Again, the selection was made across the three agricultural zones, ensuring that all the areas in the state would be represented. The areas selected were: Ikwuano local government area in Abia central, Osisoma local government area in Abia South, and Bende local government area in Abia North agricultural zones. The second stage involved a random selection of two communities from each of the selected local goverment areas, making it six communities for the study. The final stage was a random selection of 35% of the total sweet potato farmers from the list of farmers with each of the community's model farmer. The selection gave 58 farmers from Bende local government area, 76 farmers from Ikwuano local government area, and 76 farmers from Osisoma local government area. This brought the final sample of the farmers to be interviewed to 210 using a well-structured questionnaire. However, only 156 responses were found relevant and were subjected to data analyses in the study.

The questionaire was structured to elicit information on socio-economic features of the farmers, quantity, types, and prices of improved sweet potato adopted by the farmers, the quantity and unit prices of farming inputs and output of sweet patotoes, as well as perceived effect of some farming techniques in sweet patoto production on the environment. Data were analyzed using both descriptive statistics and econometric tools. The level of use of improved planting materials and some technologies of Sweet Patoto Production in the area was analyzed using descriptive statistics such as frequency and relative frequency.

The level of use and the corresponding percieved effect of some management practices (in soil ammendment practices, cropping systems, varieties planted, and sources of farming inputs) on the environment by the farmers were articulated and described using descriptive statistics.

Farmers level of technical efficiency and factors affecting technical efficiency were analyzed using the stochastic production frontier. A stochastic frontier production function is defined by:

$$Yi = f(X_i; \beta) \exp(V_i - U_i), i = 1,2 \ldots.n \qquad (1)$$

where;

Y_i is output of the i-th farm

X_i is the vector of input quantities used by the i-th farm

β is a vector of unknown parameters to be estimated

The term V_i is a symmetric error, which accounts for random variations in output due to factors beyond the control of the farmer such as weather, disease outbreaks, measurements errors, and so on. The random error V_i is assumed to be independently and identically distributed as $N(0, \dot{\rho}^2)$. The term U_i is a non-negative random variables representing inefficiency in sweet potato production relative to the stochastic frontier.

The technical efficiency of an individual farmer is defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology.

$$TE = \frac{Y_i}{Y_i^*} = \frac{f(Xi\,;\beta)\exp(Vi - Ui)}{f(Xi\,;\beta)\exp(Vi)} = \exp(-Ui) \quad (2)$$

where Y_i is the observed output of sweet patotoes and Y_i* is the frontier output which the farmer is expected to attain given his input level. The parameters of the stochastic frontier production function are estimated using the maximum likelihood method. Empirically, the stochastic production frontier function is expressed as:

$$InYi = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + Vi - Ui \quad (3)$$

where Y_i is output of sweet potatoes in kg.,

X_1 = Farm size in measured hectares

X_2 = Labour used in sweet patoto production measured in mandays,

X_3 = Sweet potatoes setts and or vines planted in kilo grammes

X_4 = Quantity of fertilizer used in kilogrammes

X_5 = Rate of interest on borrowed capital in percentage

It is expected that all the included explanatory variables, apart from rate of interest, will have a positive sign. Therefore, $\beta_0 >$; $\beta_1 > 0$; $\beta_2 > 0$; $\beta_3 > 0$; $\beta_4 > 0$ but $\beta_5 < 0$

V_i and U_i are as defined earlier. In addition, U_i is assumed, in this study, to follow a half normal distribution. The farm specific efficiency is given as 1 – TE values (Assa et al., 2012). Again, the determinants of technical inefficiency in sweet potato production follow the model formulated and estimated jointly with the stochastic frontier model in a single stage maximum likelihood estimation procedure using a specialized computer software called Frontier Version 4.1 (Coelli, 1996). This is expressed as:

$$TIE_i = b_o + b_1Z_1 + b_2Z_2 + b_3Z_3 + b_4Z_o + b_5Z_5 + b_6Z_6 + b_7Z_7 + b_8Z_8 + b_9Z_9 \quad (4)$$

where TIE_i is the technical inefficiency of the i-th farmer

Z_1 = Farmers age in years

Z_2 = Household size farmers level of formal education in years

Z_3 = Farmer's farming experience in years

Z_4 = Level of Formal Education

Z_5 = Number of technical advice and packages to the farmer by the agents in a planting season

Z_6 = Source of planting material (Dummy; '1' if it is from NRCRI or IITA and '0' otherwise)

Z_7 = Social capital, number of associations and co-operatives the farmer belongs

Z_8 = Access to Credit (Dummy variable; '1' represents access to credit and '0' otherwise

Z_9 = Depreciation of fixed inputs item measured in naira.

We expect that b_1, b_2, b_3,...b_9 are negative.

RESULTS AND DISCUSSIONS

Technologies of Sweet Potatoe Production and Their Environmental Implications

Table 1 shows the result of different technologies used in sweet patoto production in Abia State. Though inorganic fertilizers such as NPK and urea have some environmental consequences, as they have some residual effects in underground water, they appear to be the most common technologies for soil ammendment practice in sweet potato production in the area, with 65.4% of the farmers applying them. This is because it is easy to apply and farmers-friendly with nutrients present in their simplest forms and adequate proportion and easily given out to the plants roots. This corroborate Akande's (2008) finding that inorganic fertilizer seems to be common, because it is easy to apply and the nutrient is readily available to the plants, however, the high cost of acquiring it and the its relative scarcity have always made it inaccessible to farmers during planting seasons. Few (12.8%) farmers used organic fertilizer. This type of soil ammendment, though cheap and affordable within local means, may not have its nutrients easily available to the plant root. It requires some time to mineralize and release its nutrients to plants, hence the technical knowledge of its preparation and application could be the reason for its low use in the area. The result further re-

Table 1
Distribution of the Respondents Based on the Technologies Involved in Sweet Patoto Production in the State.

Technologies	Management Practices	Frequency	Percentages
	Use of drainages	0	0.0
	Irrigation	11	7.74
Soil ammendment	Organic fertilizer	20	14.08
	Inorganic fertilizer (Urea and NPK)	102	71.83
	Liming	9	6.33
	Bush burning	104	44.82
	Shifting Ccultivation	2	0.86
Cropping systems	Mixed farming	99	42.67
	Continous cropping	25	10.77
	Organic farming	2	0.86
	TIS 8164	111	38.94
	TIS 0087	110	38.59
Varieties planted	TIS 2271	39	13.68
	Ogonegurunwa	11	3.85
	Dukuduku	14	4.91
	ADP/MA&NR	109	65.26
	Root Crop Research Institute	16	9.58
Source of planting material	Market	31	18.56
	Co-operative Society	11	6.58

vealed that no farmer is practicing any form of drainage systems in the area, hence there is a possibility of excessive flooding due to excessive rainfall that comes with climate change challangies in recent times. This finding is consistent with Ebuzoeme (2015) observation that poor drainage system, where there is excessive previous rainfall, could lead to overflooding and erosion with predominanat leaching of soil nutrients. Leaching becomes excessive with the low (5.8%) use of lime. Sweet patotoes do well in soil with a higher PH; accordingly, liming is very important if output is to be increased in the area.

Again, few (7.1%) famers practice irragation system in the area, thus all year round sweet patoto production may be difficult and food insecurity status may increase in the area. Instead of irrigation systems, rainfall predominantly provides water for agricultural activities in the area, and Igwe and Stahr (2004) have emphasised excessive rainfall as the major cause of soil degradation in Eastern Nigeria. Others include the fragile nature of the soil with farming activities and deforestation, but they expose soil to erosion. As a consequence of soil erosion by the agency of water, soil nutrients are depleted, leading to a decline in crop production (Age et al., 2012). Ebuzoeme (2015) noted that a rain-fed production system that is characterised by erosion and flooding is usually prone to excessive leaching, leaving the soil more acidic. This findings seem to have characterized the soil as a sort of acidic soil and unsustainable with the type of soil management practices common in the area. Ehirim et al. (2013) noted that the relative suitability of land for root crop production is dependent on the sustainable soil management practices farmers adopt to gradually return improvised farm lands to a suitable land for crop production. Proper soil management practices such as liming, and timely use of organic amendments such as animal manures and sewage sludge compost on lands can restore increased land productivity (Al-Kaisi, 2012; Hornick & Parr, 2010).

The result further showed that bush burning is a very common practice with more than 66.7% of sweet patoto farmers engaging in it.

This practice seems to be cost-effective especially in the short run and leaves some ash deposites in the soil, which becomes lime and may increase soil PH level. However, the practice may not be a sustainable soil management practice; the heat from the burning can quickly denatures structure and other soil physical properties, or release the soil nutrients to the atmostphere thus exposing it to erosion and excessive leaching. Bush burning leaves a permanent damage to the soil, as plant nutrients that are volatile are easily converted to gases, while the practice itself increases the level of green house gases in the area. It kills soil micro and macro organisms that help in organic mater decomposition and soil erosion The gases disolve in rain water to form acid rain, which later increases soil acididty. The soil in such areas may become predominantly acidic and infertile. Another form of practice that leaves the soil in the area infetile and may lead to crop failure in the long run is continous cropping with only 28.2% of the farmers engaging in it. Continous cropping is mediated by population growth that forces farmers to cultivate on smaller (fragmented) plots where the soil eventually becomes depleted, or expands into fragile hillsides and could lead low productivity (Scherr & Yadav, 1996). Mixed cropping is another croping system that is predominant in the area with 63.5% of the farmers engaging in it. This is a copping strategy for farmers, as it is used to expand revenue and mitigate crop failure due to pest and diseases. In addition, it intensifies the use of land. Organic farming is very low with only 1.3% of the farmers engaing in it.

The common varities planted by the farmers in the area include TIS 8164, TIS 0087, and TIS 2271. Other local varieties include Ogonegburunwa and dukuduku. More than 71.2% of the farmers palnted TIS 8164, while 64.1% palnted TIS 0087. Few (25.0%) farmers planted TIS 2271, while local vareties like *Ogonegburunwa* and *Dukuduku* were planted by only 7.05% and 9.0% of the farmers. A vast majority of (69.9%) sweet patoto vines and setts were obtained from ADP, while the market supplied only 19.9% of the vines. Few (7.1% and 10.3%) of them sourced from co-operative and root crop reasearch institutes respectively. The most currently introduced improved variety of sweet patoto (TIS 2271) has not been widly used, as only 25.0% of the farmers are planting it. The study suggests that extension agencies should persuade farmers to use these varieties because of its short production time and productivity per unit area of land.

Factors of sweet patoto production in Abia State

Table 2 shows the parameters and related statistical test results obtained from the stochastic frontier production function analysis using Maximum Likelihood Estimates (MLE). Apart from labour and planting materials, all other variables like farm size, fertilizer, and rate of capital bor-

Table 2
Maximum Likelihood Estimates for the Stochastic Frontier Production Function of Sweet Potatoes Production.

Production variables	Model parameters	Estimates	SE	t-value
Constant	β_0	4.129***	0.25220	16.37
lnFarm size	β_1	0.06538**	0.03020	2.165
lnLabour	β_2	0.09322	0.05526	1.687
lnPlanting material	β_3	0.00038	0.00670	0.057
lnFertilizer	β_4	0.08142**	0.04083	1.994
Rate of Interest on Loan	β_5	-0.00413***	0.00205	2.011
Returns to Scale		0.23627		
Diagnostic statistics				
Loglikelihood Function	δ^2	-105.601	7.621	
Sigma squared	μ	0.01469***		
Lamda	γ	0.20807	9.218	
Gamma		0.04303***		

*p<0.1, **p<0.05, ***p<0.01

Table 3
Technical Efficiency Levels of Sweet Patoto Farmers in Abia State

Technical Efficiency Limits	Frequency	Percentages
Technical Efficiency ≤ 10.0	4	3.2
10.1 – 20.0	7	5.6
20.1 – 30.0	8	6.4
30.1 – 40.0	28	22.4
40.1 – 50.0	35	28.0
50.1 – 60.0	15	12.0
60.1 – 70.0	10	8.0
70.1 – 80.0	10	8.0
80.1 – 90.0	4	3.2
Technical Efficiency > 90	4	3.2
Total	125	
Mean efficiency	47.1	
Minimum efficiency	0.298	
Maximum efficiency	99.4	

rowing are significant at 0.05 alpha level ($p < 0.05$). Again, apart from the rate of capital borrowing, all other variables are positive and consistent with a piriori expectation in the area. Therefore, an increase in farm size and fertilizer application by 1.0 unit will give a less than 0.06538 and 0.08142 proportionate increase in output of sweet patotoes, respectively. Fertilizers play a supportive role in sweet patoto production; accordingly, their effective distribution is imperative. The study suggests the inclusion of organic fertilizers to reduce cost and environmental problems caused by the use of synthesized fertilizers in the area. Likewise, an increase in the rate of borrowing by 1.0 unit will give a less than 0.00413 decrease in output of sweet patotoes. Labour and planting materials such as sweet potatoe setts and vine, though not significant even at 10.0%, is positive; hence, it will continue to increase the level of sweet patoto production in the area. The model shows a decreasing returns to scale of 0.236 in sweet patoto production in the area. This implies that an increase in the use of aggregate farm inputs used in sweet potatoe production by 1 unit can give a less than 0.763 unit of sweet patoto output in the area. At aggregate level, farmers are advised to respond to production by reducing input use to an equal proprotion of output by 76.3% in the area.

The functional parameters of maximum likelihood estimates has a sigma square (σ^2) value of 0.01469, significant at $p < 0.05$ critical level. The variance parameters (lamda), which showed the ratio of standard error {u (∂_u)} to the standard error {v (∂_v)} is 0.208 or 20.8%. Furthermore, the gamma ratio estimated from the lamda value is 0.04303 and significant at $p < 0.05$ critical level. This value is less than 1.0 which is consistent with the postulation that a true gamma value should be less than 1.0 and significant (Assa et al., 2012). The ratio captures the level of discrepancies in technical efficiency by farmers and about 4.30% discrepancies in observed and frontier output are due to potato farmers technical inefficiencies. Gamma ratio according to Ogundari and Ojo (2006) is the relative magnitude of variance (δ^2) associated with inefficiency effect. Therefore, goodness of fit and correctness of the specified distributional assumptions of dominance of U on V can be acertained, provided the value is significantly different from zero.

Technical efficiency in sweet patoto production in Abia State

The mean technical efficiency distribution of the sweet patoto farmers as shown in Table 3 is 47.1%, implying that, on average, the technical efficiency of the farmers in the area is about 47.1%. This value ranges from a minimum efficiency level of 0.298% to a maximum technical effeicent level of 99.4% in the area. It could be deduced from this result that there is a wide disparity in farmers' technical efficiencies and

Table 4
Determinants of Technical Inefficiency in Sweet Patoto Production in Abia State

Inefficiency Effects	Parameters	Co-efficient	SE	t-value
Constant	b_0	-0.2305***	0.0245	-9.424
Age	b_1	9.7760**	4.4360	2.203
Household size	b_2	-1.8020***	0.0208	-8.676
Experience	b_3	-9.4710**	4.1350	-2.290
Education	b_4	2.6160***	0.1353	19.320
Technical Service/Advice	b_5	-0.0540	0.1544	0.348
Source of Planting Material	b_6	-0.9188**	0.3614	2.542
Social Capital	b_7	9.3901	0.2772	0.034
Access to credit	b_8	-0.1353	0.4059	-0.333
Depreciation	b_9	-3.4060	6.7890	-0.502

*p<0.1, **p<0.05, ***p<0.01

there is room for bridging their technical efficiencies. Many farmers are found below the overall mean technical efficiency. For instance around 22.4% are less than 40% but greater than 30% technically effcient. Again, about 15.2% of farmers are below 30.0% technical efficiency. However, only 28.0% of the sweet patoto farmers are between 40.1 to 50% technically efficient, whereas 34.4% of them are more than 50% technically efficient in sweet patoto production in the area. This shows that with efforts made by farmers toward efficient technology use in sweet patoto production, high technical efficiency can be achieved in the long run, and this can enhance output.

Determinants of technical inefficiency sweet patoto production

The technical inefficiency model as shown in Table 4. has age and formal education level positive and significant at $p < 0.05$ critical level. Others like household size and farming experience, though significant at $p < 0.05$ critical level, are negative to technical inefficiency of the farmers in the area. It can, then, be contended that apart from age and education, an increase in household size and farming experience can reduce farmers technical inefficiency. This is consistent with a priori expectation and akin to the findings of (Kapinga et al.,1997). Farming experience increases farming skills that can increase technical efficiency. In a similar vein, household size, though increases the level of family labour, does not increase the quality of labour required for increased efficiency.

In antithesis to a piriori expectation, age increases with technical inefficiency. This implies that farmers with old age are more technically inefficient than the young farmers. Younger farmers are more competent, risk loving and friendly, accept inovations and technology that can enhance farmers efficiency in potato production in the area. The study therefore suggests that young farmers should be encouraged in potatoe farming system to help reduce technical inefficiency. Similarly, the farmers level of formal education, tends to increase with increase in technical inefficiency. This is contrary to a piriori expectation, as education, which is expected to increase farming skills and educate farmers on the use of improved farming skill, cannot increase technical efficiency in the area. Access to credit and depreciation of fixed input, though not significat at 0.05 critical level, are still negative. This implies that increasing access to credit will reduce technical inefficiency just like depreciation. It could be deduced from the findings that while access to credit provides enough capital for acquisition of farm inputs that can in turn produce more output at a reduced cost, increased depreciation increases the overall cost of production, and hence inefficiency.

CONCLUSION AND RECOMMENDATIONS

The study x-rayed the technologies of sweet potato production such as soil amendment practices, cropping systems, improved crop varieties planted, and sources of planting materials used in the area. The use of inorganic fertilizer is very common with about 65.378% of the farmers' engaging in the use of inorganic fertilizers like NPK in the planting of sweet patotes. About (66.67%) of the farmers practice bush burning which seems to reduce the overhead-cost incurred in clearing the land at the beginning of every planting season. The common varieties of potatoes planted by the farmers in the area include TIS 8164, TIS 0087, and TIS 2271. Other local varieties include *Ogonegburunwa* and *dukuduku*. The results showed that all significantly estimated coefficients were negative except age and education. It can, then, be deduced that apart from age and education, increase in household size and farming experience reduces farmers technical inefficiency. The wide disparity in farmers' technical efficiencies ranging from 0.298% to 99.4% and a mean of 47.1% suggested a need to bridge the gap. Hence, a reduction in household size, farming experience, and sourcing of planting materials from NRCRI or IITA is believed to increase farmers' technical inefficiency, which reduces with age and formal educational level of sweet patoto farmers in the area. Reducing bush burning but increasing liming, inclusion of organic soil ammendments, and irrigation practicies when coupled with the use of young and educated farmers reduce environmental damages and increase technical efficiency in sweet patoto production in the area. The study suggests young farmers to dominate the production so that adoption of improved technologies for improved output will become easy. Further, education should be given utmost priority for easy adoption of innovation in the sector.

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