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PROFIT EFFICIENCY IN PRODUCTION OF SOME SELECTED UNDERUTILISED INDIGENOUS VEGETABLES IN SOUTH WEST NIGERIA FROM GENDER PERSPECTIVE

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ABSTRACT

The study determined the profit efficiency and its determinants of producers of Telfairia occidentalis, Solanum macrocarpon, Amaranthus viridis and Solanecio biafrae. A multi-stage sampling technique involving the purposive selection of four States in Southwest Nigeria, where NICANVEG project was implemented was used. Proportionate and simple random sampling techniques were employed to select 194 producers. Primary data were collected using a structured questionnaire. Stochastic Frontier Profit Function (SFPF) was used to determine the profit efficiency and its determinants. The study found that UIVs producers were profit efficient. Male producers were significantly (t=2.65, p<0.05 and 2.45, p<0.05) more efficient in the production of T. occidentalis and S. biafrae but the female producers were significantly (t=-2.56, p=0.05 and t=-2.16, p=0.05) more efficient in the production of S. macrocarpon and A. viridis. The factors that determined the profit efficiency of the UIVs producers include quantity of UIVs produced, value added, cost of production and the worth of quantity wasted. The socioeconomic factors that determined the inefficiency of the UIVs producers were age, farming experience, gender, education, farm distance from home and household size. In conclusion, a high profit efficiency levels found for the UIVs producers in the study is an ample sign that UIVs have the potential to generate higher household income, especially for women folks.

Keywords: Gender, Indigenous vegetables, Nigeria, profit efficiency, underutilised

INTRODUCTION

Underutilized Indigenous Vegetables (UIVs) are vegetables that were once grown more widely or intensively but are falling into disuse for a variety of agronomic, genetic, economic and cultural reasons, they are species whose potentials have not been fully realised. Farmers and consumers are using these crops less because they are in some ways not competitive with other species in the same agricultural environment (International Plant Genetics Research Institute, 2002). They may also refer to local varieties of vegetables currently abandoned by farmers or in decline but which could be revived through specific interventions to boost agrobiodiversity (Dansi *et al.*, 2012; Imathiu, 2021).

In many traditional farming systems worldwide, agrobiodiversity plays a great part in the livelihoods of the poor resource rural households (Moni *et al.*, 2011; Shrestha, 2019). It is widely recognized that embedding the use of neglected and underutilized indigenous vegetables (UIVs) into traditional farming household systems of the resource-poor small-scale farmers, holds significant potential for improving food security, achieving more balanced nutrition, conserving biodiversity, and income generation thereby creating employment along the value chain (Ebert, 2014; Jena, 2018; Conti *et al*., 2019; Tanimonure *et al*., 2021).

These UIVs account for about 10% of the world higher plants often regarded as weeds (Nnamani *et al*., 2009). Some indigenous leafy vegetables (ILVs) grow in the wild and are readily available in the field as they do not require any formal cultivation. Many of them are resilient, adaptive, and tolerate adverse climatic conditions more than the exotic species as they can be raised comparatively at lower management cost and on marginal soil (Raghuvanshi and Singh, 2001; Nnamani *et al*., 2009). This offers a significant opportunity for the poor people to earn a living, without requiring large capital investments (Maroyi, 2011; Ebert, 2014; Tanimonure, 2021).

It is interesting to know that the production and the marketing of these vegetables are carried out by women (Howard, 2003; Ayanwale *et al*., 2011; Conti *et al*., 2019). Due to power structures and different gender roles, men prefer crops produced exclusively for sales, whereas women tend to look at the welfare returns to their families. The women are the target groups for discovering the utilization and production of ILVs as they are still mainly subsistence crops (Maundu, 1997; Stokoe, 2000 and Nguni and Mwila 2007). Also, Puspitawati *et al.* (2009) showed that men produce and sell main agricultural products such as rice, corn or cassava, while women may produce and sell minor vegetables. Commercial production of indigenous vegetables, therefore, offers an important entry point for poor and resource constrained rural women (Chadha and Mndiga, 2006).

Despite the roles these UIVs play, they are not in some ways competitive with other species in the same agricultural environment (International Plant Genetics Research Institute, 2002). They are referred to as local varieties of vegetables neglected by farmers but which could be invigorated through specific interventions.

The need to promote the production, marketing and consumption of these UIVs in Nigeria for food security and poverty reduction goals prompted the coming together of various researchers in the field of Agriculture and Food Technology from Obafemi Awolowo University and Osun State University in a project tagged NICANVEG. This was done with the aid of a grant from International Development Research Centre (IDRC) and with financial support from the Government of Canada, provided through the Department of Foreign Affairs, Trade and Development Canada (DFATD) in 2011. Not until this time, the neglect and inefficiency in the production of these indigenous vegetables have also led to the inefficiencies in both their marketing and consumption, and hence, little or no attention was paid to their value chain (Collins and Hawtin, 1999; Padulosi *et al.,* 1999).

Although, to a great extent NICANVEG project had bridged the gap between production, marketing and consumption of UIVs in the study area (Adebooye *et al*., 2014). However, in spite of UIVs' acknowledged nutritional and fSood security benefits, the economic activities along its value chain can neither be said to be efficient nor gender balanced. The Nigeria Canada

Vegetable (NICANVEG) project was undertaken to improve the profit efficiency along UIVs value chain. The extent to which the profit efficiency has been enhanced in the production of UIVs has not been statistically documented.

The past studies on UIVs in Nigeria had focused on technical efficiency in production of UIVs (Ajekiigbe *et al.,* 2018), socio-economic analysis of the marketing chain for UIVs (Ayanwale *et al.*, 2011), analysis of household demand for UIVs (Ayanwale *et al*., 2016), and production and consumption of UIVs in Southwest, Nigeria (Ayinde *et al.*, 2017). There is dearth of study on the profit efficiency of UIVs in Southwest Nigeria. This study, therefore, analysed the profit efficiency of the UIVs producers, considering various value addition activities they carried out and also the socioeconomic variables that determine their inefficiency in Southwest Nigeria in order to verify if their production activities are profit efficient and also identify factors that are responsible for their profit efficiencies. This study will add to the body of literature on UIVs in Southwest, Nigeria.

METHODOLOGY

Study area

The study area was Southwest Nigeria (figure 1). The area lies between longitude 2^{o} 31\` and 6$^{o}$ 00\` East and Latitude 6^{o} 21\` and 8$^{o}$ 37\` North with a total land area of 77,818 km^2 and a population of 14,840,360 in 2016. The study area is bounded in the East by Edo and Delta States, in the North by Kwara and Kogi States, in the West by the Republic of Benin and in the south by the Gulf of Guinea. The region comprises six States namely Oyo, Ogun, Osun, Ondo, Ekiti and Lagos and is distinctly divided into three major agro-ecological zones (Rain Forest zone, Swamp Forest zone and Derived Savana zone) with varying climatic conditions. The forest agro-ecological zone has annual rainfall in the range of 1,600 to 2,400 mm, with cropping seasons between April and November with dry spells from December to March. On the other hand, the derived savannah ecosystem has mean annual rainfall ranging from 800 to 1500 mm with cropping seasons between April and November. The soil types ranged from sandy to clayey in texture with soil reaction ranging from acidic to slightly basic. Soil fertility statuses and crop species diversity also vary widely in different locations in the region.

This proposed study was carried out in two of the agro-ecological zones (Rain Forest zone and Derived Savannah zone) where agriculture is widely practised without any threat of flood. The states in these ecological zones are Oyo, Osun, Ondo and Ekiti. The major crops cultivated are maize, cassava, cocoyam, yam, vegetables and edible fruits. Cultivation of indigenous vegetables is one of the emerging agricultural activities in the area.

Sample size selection

A simplified formula (equation 1) developed by Yamane (1967) was used to calculate the producers' sample size. A 95% confidence level and P = 0.05 were assumed in the equation:

$n = N/1+ N(e)^2$ ………………… (1)

where,

n is the sample size

N is the population size

e is the desired level of precision.

The producer sample size arrived at was 194 which was approximately 51% of the producers' population who participated directly in the NICANVEG programme.

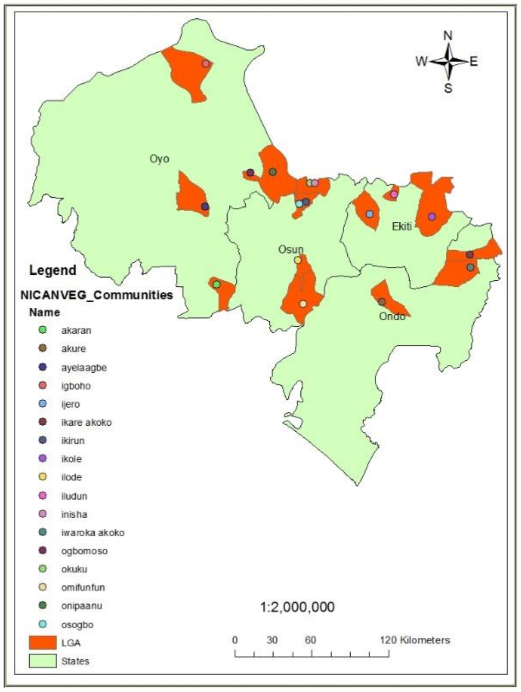

Fig 1: Map showing the study area

Sampling Procedure

For the selection of a representative sample of 194 UIVs producers, a multistage sampling technique was employed. At the first stage, four out of six States covered by the NICANVEG programme in Southwest Nigeria were purposively selected. At the second stage, complete selection of all the 16 NICANVEG Local Government Areas (LGAs) was done and at the third stage, complete selection of all the 17 NICANVEG communities or sites from the 16 LGAs was also carried out. At the fourth stage, NICANVEG farmers were stratified into male and female. This was not difficult to achieve because the component of gender had been incorporated into the project from the onset. In most cases, equal number of male and female UIVs farmers was ensured in each NICANVEG site. A total of 34 strata were obtained in all the 17 sample NICANVEG communities. And at the last stage, equal number of male and female were randomly selected from each stratum to give a total of 194 respondents. At the end of the survey, 188 (96.91%) questionnaires were found to be properly completed and the information provided were used for the analysis in the study.

Analytical Techniques

Analysis of Profit Efficiency using Stochastic Frontier Profit Function

Coelli (1996) model was used to specify the stochastic frontier function with behaviour inefficiency components and to estimate all parameters together in one step maximum likelihood estimation following Adesina and Djato (1996), Beger and Mester (1997), Maudos *et al*. (2003), and Ogundari (2006). The explicit Cobb-Douglas functional form for the UIVs farmers in the study area is therefore specified as follows:

$$ln\Pi = ln\beta_0 + \beta_1 lnY_{1i} + \beta_2 lnP_{1i} + \beta_3 lnP_{2i} + \beta_4 lnP_{3i} + (V_i - U_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:

$\prod_i$ represents normalized profit of the jth farm computed as total revenue less variable cost divided by firm specific output (UIV) price;

Y_1 represents output of UIV (kg/year);

P_1 represents normalized value-added cost per kg of UIV;

P_2 represents normalized cost of production per kg of UIV;

P_3 represents normalized worth of waste per kg of UIV;
β is Vector coefficients to be estimated;
Vi is Random variability in the production that cannot be influenced by the firm and;
Ui is Deviation from maximum potential profit attributable to profit inefficiency of ith farmer.

$$U_i = \partial_0 + \partial_1 M_{1i} + \partial_2 M_{2i} + \partial_3 M_{3i} + \partial_4 M_{4i} + \partial_5 M_{5i} + \partial_6 M_{6i} \dots\dots\dots\dots\dots\dots\dots\dots\dots. (3)$$

M_1 is the age of chain actor;
M_2 is the level of education of chain actor;
M_3 is the household size of the chain actor;
M_4 is the farming experience;
M_5 represents distance to UIVs farm from home; and
M_6 represents the gender of respondents

These socio-economic variables are included in the model to indicate their possible influence on the profit efficiencies of the UIVs farmers (determinant of profit inefficiency).

The variance of the random errors, σ2v and that of the profit inefficiency effect σ2u and overall variance of the model σ2 are related thus: σ2 = σ2v + σ2u, measure the total variation of profit from the frontier which can be attributed to profit inefficiency (Battese and Corra, 1977). Battese and Coelli (1995) provided log likelihood function after replacing σ2v and σ2u with σ2 = σ2v + σ2u and thus estimating gamma (γ) as: γ = σ2u/ σ2v + σ2u. The parameter γ represents the share of inefficiency in the overall residual variance with values in interval 0 and 1. A value of 1 suggests the existence of a deterministic frontier, whereas a value of 0 could be seen as evidence in the favour of OLS estimation. The estimate for all parameters of the stochastic frontier profit function and the inefficiency model were simultaneously obtained using the programme FRONTIER VERSION 4.1c (Coelli,1996).

RESULTS AND DISCUSSION

Distribution of selected UIVs' Producers by their Profit Efficiencies

The distribution of the UIVs' producers by the profit efficiency in the study area is presented in Table 1. For the producers of T. occidentalis, the results indicated a profit efficiency range of 29% to 98%, for the pooled, 57% to 98% range for the male and 26% to 98% for the female. The result also revealed that the profit efficiency skewed heavily in the >80% range, representing 93.49%, 96.47% and 92.86% for the pooled, male, and female producers, respectively. The mean estimate was 90.26%, 92.69% and 89.32% for the pooled, male, and female, respectively. These results imply that while the producers of *T. occidentalis* could increase their profits by 9.74%, male and female producers could increase their profit by 7.31% and 10.68%, respectively. It was noteworthy that male producers of T. occidentalis were significantly ($t = 2.65$, $p< 0.05$) more profit efficient than their female counterparts.

For the producers of *S. macrocarpon*, a profit efficiency range of 6% to 99%, for the pooled, 28% to 100% range for the male and 68% to 99% for the female. The result also revealed that the profit efficiency skewed heavily in the >80% range, representing 98.63%, 94.52% and 94.52% for the pooled male and female producers, respectively. The mean estimate was 96.14%, 91.00% and

94.58% for the pooled, male, and female, respectively. These imply that generally, the producers of *S. macrocarpon* could increase their profits by 3.86%, and specifically, male and female producers could increase their profit by 9.00% and 5.42%, respectively. It was noteworthy that female producers of S. macrocarpon were significantly (t = -2.56, p< 0.05) more profit efficient than their male counterparts.

The profit efficiency is of *A. viridis* producers ranged between 38% and 98%, for the pooled, 28% to 100% range for the male and 68% and 99% for the female. The result also revealed that the profit efficiency skewed heavily in the >80% range, representing 89.51%, 94.29% and 94.52% for the pooled, male, and female producers, respectively. The mean estimates were 89.20%, 91.00% and 94.58% for the pooled male and female, respectively. These implies that generally, the producers of *A. viridis* could increase their profits by 10.80%, specifically, male and female producers could increase their profit by 9.00% and 5.42%, respectively. Female producers of *A. viridis* were significantly (t = -2.16, p< 0.05) more profit efficient than their male counterparts.

Also, the profit efficiency of *S. biafrae* producers in the study area ranged between 46% and 98% for the pooled, 87% to 97% range for the male and 39% and 100% for the female. The result further revealed that the profit efficiency skewed heavily in the >80% range, representing 97.26%, 100% and 82.76% for the pooled male and female producers, respectively. The mean estimate was 93.31%, 92.45% and 87.34% for the pooled, male, and female, respectively. These percentages imply that in general, the producers of *S. biafrae* could increase their profits by 6.69%, male and female producers could increase their profit by 7.55% and 12.66%, respectively. The male producers of *S. biafrae* were significantly (t = 2.65, p< 0.05) more profit efficient than their female counterparts.

These results corroborate Ajekiigbe *et al.*, (2018) and Mulaudzi *et al.*, (2019) who also reported that UIVs farmers were technically efficient and hence, made profit from their production activities.

TABLE 1: DISTRIBUTION OF SELECTED UIVS PRODUCERS BY THEIR PROFIT EFFICIENCIES

Profit efficiency (%)	***Telfairia occidentalis***			***Solanum macrocarpon***			***Amaranthus viridis***			***Solanecio biafrae***		
	Pooled	**Male**	**Female**	**Pooled**	**Male**	**Female**	**Pooled**	**Male**	**Female**	**Pooled**	**Male**	**Female**
0 – 20	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
21 – 40	1(0.59)	0(0)	1(1.19)	0(0)	1(1.37)	0(0)	1(0.70)	1(1.43)	0(0)	0(0)	0(0)	1(3.45)
41 – 60	1(0.59)	1(1.18)	1(1.19)	1(0.68)	0(0)	0(0)	4(2.80)	0(0)	0(0)	1(1.37)	0(0)	1(3.45)
61 – 80	9(5.33)	2(2.35)	4(4.76)	1(0.68)	3(4.11)	4(5.48)	10(6.99)	3(4.29)	4(5.48)	1(1.37)	0(0)	3(10.34)
>80	158(93.49)	82(96.47)	78(92.86)	144(98.63)	69(94.52)	69(94.52)	128(89.51)	66(94.29)	69(94.52)	71(97.26)	44(100)	24(82.76)
Total	169	85	84	146	73	73	143	70	73	73	44	29
Minimum	29.00	57.00	26.00	6.00	28.00	68.00	38.00	28.00	68.00	46	87.00	39.00
Maximum	98.00	98.00	98.00	99.00	100	99.00	98.00	100.00	99.00	98	97.00	100
Mean	90.26	92.69	89.32	96.14	91.00	94.58	89.20	91.00	94.58	93.31	92.45	87.34
SD	8.34	5.97	10.06	3.98	10.54	5.65	9.89	10.54	5.65	**6.91**	**2.78**	13.44
T-test	2.65***			-2.56***			**-2.16****			2.45***		

Note: ***, ** represent 1% and 5% level of significance

Values in parenthesis are percentages

Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Profit Model for Selected UIVs Farms in Southwest Nigeria

This section presents the variables that influence profit efficiencies of the four selected UIVs and the socioeconomic variables that influence their inefficiencies following Adesina and Djato (1996), Beger and Mester (1997), Maudos *et al.* (2003), Ogundari (2006), and Bamiro *et al.* (2013) as presented in Table 2. Generally, for all the selected UIVs, the estimated sigma squared was significantly different from zero at 1% level of significance. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. In addition, the magnitude of the variance ratios, λ were estimated to be high and close to one, suggesting that the systematic influences that are unexplained by the profit function are the dominant sources of errors. This means that 98%, 83%, 94% and 93% for *T. occidentalis*, *S. macrocarpon*, *A. virids* and *S. biafrae,* respectively of the variation in profit among the farms were due to differences in profit efficiencies. This confirms the relevance of Stochastic frontier profit functions, using the Maximum Likelihood Estimator (MLE).

Using the maximum-likelihood estimates for the parameters of the profit frontier (Table 2), the elasticities of frontier profit with respect to output, normalized value-added cost, normalized cost of production, and normalized worth of waste, per Kg of *T. occidentalis* were estimated. The elasticities estimates were -0.079, 0.077, -0.332, and -0.014, respectively for the pooled data, -0.157, -0.015, -0.436, and 0.030, respectively for male producers, and -0.062, 0.090, -0.275 and -0.048, respectively for female producers.

Further, the estimates showed that generally, output was negative and statistically significant ($\beta = -0.079$, $p < 0.01$) for the producers in the study area, output estimates for both males and females followed the same pattern, ($\beta = -0.157$, $p < 0.01$ and $\beta = -0.062$, $p < 0.01$, respectively). The implication of this is that for 1% increase in the output of *T. occidentalis* by the pooled, male, and female producers, their profit will fall by 8%, 16% and 6%, respectively. This may be as a result of the perishability nature of UIVs generally and lack of processing facilities to prevent wastage and so, any quantity of vegetable produced in excess will lead to wastage thereby leading to reduction in the profit that is accrued to the producers. It is noteworthy that male producers' profit will fall more (16%) than their female counterparts (6%). This is probably because female producers add more value to the vegetables to reduce waste, which could lead to reduction in profit than male (Tanimonure *et al*., 2019).

Also, the more value-added cost incurred generally, by producers and specifically by female producers, the more profit they made. Value added cost estimates were positive and significant ($\beta = 0.077$, $p < 0.01$ and $\beta = 0.090$, $p < 0.01$) for pooled and female producers respectively. The result showed that whenever there was 1% increase in the cost incurred in adding value by pooled and female *T. occidentalis* producers, their profit would increase by 7% and 9%, respectively. This implies that in the business of *T. occidentalis*, the more value (value such as place, form, time among others) added, the higher the profit made by the producers. Also, the result implies that female *T. occidentalis* producers add more value and hence, more profit than their male counterparts.

Cost of production was found to be negative and significant (β = -0.332, p< 0.01, β = -0.436, p< 0.01 and β = -0.275, p< 0.01) for pooled, male, and female producers. The implications of this are that, if cost of producing 1Kg of *T. occidentalis* by the pooled, male, and female producers was increased by 1%, their profit would reduce by 33%, 44% and 27%, respectively. The producers therefore, must operate at minimum cost possible in order to maximize profit. It is worthy of note that increase in cost of production will cause more reduction in male farmers' profit than that of female. This is probably because most male producers sell their produce at the farm gate at lower prices compared with female producers who add place, time and form values to their produce for higher prices (Tanimonure *et al*., 2019).

In the inefficiency model, the estimated coefficient for age significantly (β = -0.049, p< 0.01, β = -0.019, p< 0.05 and β = -0.075, p< 0.10) influenced inefficiency of the pooled, male and female, respectively. One-year increase in the age of pooled, male and female producers of *T. occidentalis* will reduce inefficiency of pooled, male, and female by 5%, 2% and 8%, respectively.

Farming experience was also a significant (β = -0.037, p< 0.10) variable that reduced inefficiency as well. One-year increase in the experience of producers generally will reduce their inefficiency by 4%. Gender also influenced inefficiency positively (β = 0.58, p< 0.10). The positive coefficient of gender (male = 1 and female = 0) indicated that female producers were more profit efficient than their male counterparts. This result is at variance with Mulaudzi *et al*., (2019) who reported negative influence of gender on inefficiency, which indicated that male producers of UIVs were more profit efficient than their female counterparts.

The elasticities of frontier profit with respect to output, normalized value-added cost per Kg of *S. macrocarpon*, normalized cost of production per Kg of *S. macrocarpon*, and normalized worth of waste per Kg of *S. macrocarpon* were estimated. The elasticities estimates were -0.016, 0.001, -0.340, and -0.057, respectively for the pooled data, 0.035, 0.003, -0.160, and 0.032, respectively for male producers and -0.023, -0.042, -0.238, and -0.056, respectively for female producers.

The estimates showed that output was positive and statistically significant (β = 0.035, p< 0.01) for male producers in the study area. The implication of this is that for 1% increase in the output of *S. macrocarpon* by the male producers, their profit will increase by 4%. Cost of production was found to be negative and significant (β = -0.034, p< 0.01, β = -0.160, p< 0.01 and β = -0.238, p< 0.01) for pooled, male, and female producers, respectively. The implication of this is that, if cost of producing 1Kg of *S. macrocarpon* by the pooled, male and female producers is increased by 1%, their profit will reduce by 34%, 16% and 24%, respectively. Therefore, the producers of *S. macrocarpon* must ensure minimum cost in order to maximize their profit. The female producers will experience more reduction in profit than their male counterpart if cost of production is increased.

Also, worth of waste was found to be negative and significant (β = -0.057, p< 0.01 and β = -0.056, p< 0.01) for pooled and female producers. The implications of this are that if the worth of waste per 1Kg of *S. macrocarpon* for the pooled and female producers is increased by 1%, their profit will reduce by 6% and 6%, respectively. The producers must minimize the quantity of *S. macrocarpon* that is wasted so as to maximize profit. Meanwhile, the variable was significant (β = 0.032, p< 0.01) and positive for male producers.

In the inefficiency model, the estimated coefficient for age significantly (β = -0.004, p< 0.01 and β = 0.005, p< 0.10) influenced inefficiency of the pooled and female producers, respectively. While one-year increase in the age of pooled producers' data will reduce inefficiency by 0.4%, that of the female producers will increase by 0.5%. Educational level of all the farmers and that of the male producers reduced inefficiency significantly (β = -0.141, p< 0.01 and β = 0.204, p< 0.05). This implies 14% and 20% reduction in the inefficiency of all the *S. macrocarpon* producers and male producers, respectively whenever their level of education rises by one level. This result is similar to that of Mulaudzi *et al.,* (2019), who reported that education of UIVs farmers reduced inefficiency significantly.

Household size reduced the inefficiency of female producers significantly (β = 0.098, p< 0.05), implying, additional member of household would reduce inefficiency by 10%. Farming experience was significant (β = 0.021, p< 0.10) and increased inefficiency of male producers, meaning, one-year increase in farming experience would increase their inefficiency by 2%. Farm distance was also found to be significant (β = 0.020, p< 0.01, β = -0.075, p< 0.10 and β = -0.012, p< 0.10) for the pooled, male, and female producers, respectively. The implications of this are that for every kilometer increase in the *S. macrocarpon* farm distance, the inefficiency of all the farmers will increase by 2% but reduce by 8% and 1% for male and female respectively. Gender also influenced inefficiency positively (β = 0.58, p< 0.10). The positive coefficient of gender (male = 1 and female = 0) indicated that female producers were more profit efficient than their male counterparts.

The elasticities of frontier profit with respect to output, normalized value-added cost, normalized cost of production, and normalized worth of waste, per Kg of *A. viridis* were estimated. The elasticities estimates were 0.009, -0.095, -0.279, and -0.078, respectively for the pooled data, 0.048, -0.113, -0.-237, and -0.048, respectively for male producers and -0.027, -0.049, -0.285, and -0.062, respectively for female producers.

MAXIMUM LIKELIHOOD ESTIMATES FOR PARAMETERS OF THE STOCHASTIC FRONTIER PROFIT MODEL FOR SELECTED UIVS FARM IN SOUTHWEST NIGERIA

Variable (Parameter)	Pooled			Male			Female		
	Coefficient	Standard error	t ratio	Coefficient	Standard error	t ratio	Coefficient	Standard error	t ratio
Telfairia occidentalis									
Intercept (β_0)	2.964	0.134	22.096***	3.3529	0.2275	14.7401***	2.8434	0.1400	20.3052***
Y (β_1)	-0.079	0.028	-2.806***	-0.1570	0.0479	-3.2770***	-0.0619	0.0298	-2.0800**
P_1 (β_2)	0.077	0.022	3.571***	-0.0151	0.0326	-0.4629	0.0898	0.0408	2.2035**
P_2 (β_3)	-0.332	0.043	-7.666***	-0.4363	0.0639	-6.8311***	-0.2750	0.0568	-4.8372***
P_3 (β_4)	-0.014	0.021	-0.685	0.0304	0.0280	1.0860	-0.0476	0.0332	-1.4352
Inefficiency									
M_1 (δ_1)	-0.049	0.010	-5.017***	-0.0185	0.0154	-1.9093**	-0.0752	0.0433	-1.7390*
M_2 (δ_2)	-0.012	0.025	-0.495	0.0262	0.0187	1.4058	0.0175	0.0377	0.4625
M_3 (δ_3)	0.008	0.027	0.294	0.0406	0.0383	1.0595	0.0087	0.0410	0.2127
M_4 (δ_4)	-0.037	0.009	-3.975***	-0.0365	0.0300	-1.2165	-0.0143	0.0214	-0.6680
M_5 (δ_5)	-0.026	0.028	-0.913	-0.0395	0.0269	-1.4686	-0.0523	0.0462	-1.1337
M_6 (δ_6)	0.567	0.116	4.869***						
Sigma-squared (σ2)	0.294	0.062	4.717***	0.0952	0.0570	1.6695*	0.4718	0.2398	1.9676**
Gamma (λ)	0.980	0.007	137.622***	0.9397	0.0364	25.8417***	0.9905	0.0055	179.4050***
Log likelihood function (LLF)	115.6808			72.1876			54.7623		
LR test of the one-sided error (LR)	72.5923			18.2458			54.500		
Solanum macrocarpon									
Intercept (β_0)	2.6904	0.1085	24.8013***	0.4896	0.0359	13.6383***	0.7821	0.0946	8.2712***
Y (β_1)	-0.0163	0.0242	-0.6725	0.0354	0.0066	5.3462***	-0.0233	0.0179	-1.3019
P_1 (β_2)	0.0006	0.0268	0.0220	0.0034	0.0093	0.3665	-0.0416	0.0282	-1.4765
P_2 (β_3)	-0.3402	0.0410	-8.2998***	-0.1604	0.0169	-9.4723***	-0.2379	0.0379	-6.2741***
P_3 (β_4)	-0.0573	0.0224	-2.5628***	0.0319	0.0127	2.5213***	-0.0563	0.0207	-2.7221***
Inefficiency									
M_1 (δ_1)	-0.0037	0.0015	-2.4162***	-0.0049	0.0048	-1.0247	0.0052	0.0029	1.7622*
M_2 (δ_2)	-0.1405	0.0163	-8.6317***	-0.2041	0.0928	-2.1985**	0.0103	0.0070	1.4651
M_3 (δ_3)	0.0058	0.0109	0.5287	-0.0416	0.0334	-1.2476	-0.0985	0.0488	-2.0192**
M_4 (δ_4)	0.0025	0.0028	0.8887	0.0209	0.0119	1.7610*	-0.0010	0.0032	-0.2973
M_5 (δ_5)	0.0195	0.0062	3.1468***	-0.0750	0.0411	-1.8261*	-0.0119	0.0074	-1.5999*

M6 (δ6)	0.3194	0.0546	5.8475***						
Sigma-squared (σ2)	0.0344	0.0035	9.8379***	0.1944	0.0828	2.3462***	0.0225	0.0082	2.7298***
Gamma (λ)	0.8301	0.0327	25.3646***	0.9999	0.0001	8163.62***	0.9651	0.0201	47.9377***
Log likelihood function (LLF)	150.8993			91.7595			108.7830		
LR test of the one-sided error (LR)	28.2759			105.5014			34.6185		
Amaranthus viridis									
Intercept (β0)	2.4740	0.1209	20.4660***	2.2546	0.2114	10.6659***	2.5984	0.1250	20.7878***
Y (β1)	0.0088	0.0274	0.3204	0.0476	0.0473	1.0061	-0.0270	0.0289	-0.9334
P1 (β2)	-0.0945	0.0273	-3.4570***	-0.1130	0.0354	-3.1938***	-0.0490	0.0334	-1.4682
P2 (β3)	-0.2786	0.0464	-6.0050***	-0.2368	0.0860	-2.7518***	-0.2852	0.0468	-6.0904***
P3 (β4)	-0.0784	0.0216	-3.6339***	-0.0477	0.0394	-1.2102	-0.0621	0.0274	-2.2692***
Inefficiency									
M1 (δ1)	-0.0072	0.0048	-1.4850	0.0090	0.0064	1.3922	-0.0018	0.0030	-0.5976
M2 (δ2)	-0.0341	0.0251	-1.3576	-0.0007	0.0238	-0.0310	0.0191	0.0125	1.5282
M3 (δ3)	-0.0691	0.0369	-1.8703**	-0.1908	0.1378	-1.3843	-0.0142	0.0178	-0.7944
M4 (δ4)	-0.0115	0.0077	-1.4948	-0.0340	0.0271	-1.2559	0.0027	0.0046	0.5917
M5 (δ5)	-0.0630	0.0279	-2.2597***	-0.2044	0.1518	-1.3468	0.0025	0.0084	0.3023
M6 (δ6)	1.1785	0.4876	2.4172***						
Sigma-squared (σ2)	0.0933	0.0332	2.8108***	0.2747	0.1653	1.6620*	0.0168	0.0093	1.8060*
Gamma (λ)	0.9361	0.0293	31.9776***	0.9724	0.0193	50.3165***	0.8470	0.1139	7.4366***
Log likelihood function (LLF)	97.4205			36.082			74.4524		
LR test of the one-sided error (LR)	73.1271			29.3591			8.2720		
Solanecio biafrae									
Intercept (β0)	2.9566	0.1386	21.3389***	2.9278	0.2086	14.0357***	2.7249	0.2118	12.8634***
Y (β1)	-0.0873	0.0481	-1.8132*	-0.0954	0.0471	-2.0249**	0.0120	0.0934	0.1285
P1 (β2)	-0.0392	0.0317	-1.2379	-0.0488	0.0362	-1.3499	0.0205	0.0605	0.3394
P2 (β3)	-0.0684	0.0304	-2.2512***	-0.0511	0.0410	-1.2474	-0.1329	0.0329	-4.0411***
P3 (β4)	-0.3541	0.0548	-6.4571***	-0.3510	0.0687	-5.1059***	-0.1264	0.0831	-1.7218*
Inefficiency									
M1 (δ1)	-0.0163	0.0074	-2.2093**	0.0003	0.0013	0.2219	-0.0142	0.0139	-1.0196
M2 (δ2)	0.0721	0.0345	2.0870**	0.0091	0.0083	1.0895	0.0584	0.0516	1.1316
M3 (δ3)	-0.0898	0.0470	-1.9111**	0.0002	0.0054	0.0317	-0.1304	0.0783	-1.6649*

M_4 (δ_4)	0.0143	0.0105	1.3588	0.0016	0.0018	0.8715	0.0066	0.0332	0.1983
M_5 (δ_5)	0.0117	0.0179	0.6537	-0.0057	0.0074	-0.7783	0.0683	0.0401	1.7042*
M_6 (δ_6)	-0.2753	0.1672	-1.6469*						
Sigma-squared ($\sigma 2$)	0.0632	0.0153	4.1192***	0.0052	0.0020	2.5812***	0.1119	0.0333	3.3573***
Gamma (λ)	0.9317	0.0303	30.7460***	0.2926	1.0926	0.2678	1.0000	0.0000	135021.35***
Log likelihood function (LLF)	70.9643			54.3088			28.5289		
LR test of the one-sided error (LR)	41.0674			38.5306			35.4044		

*Note: ***,**,* are significance levels at 1%, 5% and 10% respectively*

The estimates showed that value-added cost on *A. viridis* by producers generally and specifically by male producers reduced profit significantly ($\beta = -0.095$, $p < 0.01$ and $\beta = -0.113$, $p < 0.01$). The implication of this is that for 1% increase in the value-added cost on *A. viridis* by the pooled and male producers would reduce their profit by 10% and 11% respectively. Cost of production was found to be negative and significant ($\beta = -0.279$, $p < 0.01$, $\beta = -0.237$, $p < 0.01$ and $\beta = -0.285$, $p < 0.01$) for the pooled, male, and female producers. The implication of this is that if cost of producing 1Kg of *A. viridis* by the pooled, male and female producers is increased by 1%, their profit will reduce by 28%, 24%, and 29%, respectively.

Also, worth of waste was found to be negative and significant ($\beta = -0.078$, $p < 0.01$ and $\beta = -0.062$, $p < 0.01$) for the pooled and female producers. This implies that if worth of waste per 1Kg of *A. viridis* for the pooled and female producers is increased by 1%, their profit will reduce by 8% and 6%, respectively. This also buttressed the fact that transformation of these UIVs to other products is paramount so as to reduce the quantity that is wasted and increase the profit of the producers.

In the inefficiency model, the estimated coefficient for household size, vegetable farm distance and gender significantly ($\beta = -0.069$, $p < 0.05$, $\beta = -0.063$, $p < 0.01$ and $\beta = 1.178$, $p < 0.10$) influenced inefficiency of the pooled producers. While household size and farm distance reduced inefficiency, gender increased it. This means that for one additional member of household, inefficiency will reduce by 7%. In the case of farm distance, one kilometer increase in farm distance will reduce inefficiency by 6%. The positive coefficient of gender (male = 1 and female = 0) indicated that female producers were more profit efficient than their male counterparts.

The elasticities of frontier profit with respect to output, normalized value-added cost, normalized cost of production, and normalized worth of waste, per Kg of *S. biafrae* were estimated. The elasticities estimates were -0.087, -0.039, -0.068, and -0.354, respectively for the pooled data, -0.095, -0.049, -0.051, and 0.351, respectively for male producers and 0.012, 0.021, -0.133, and -0.126, respectively for female producers.

The estimates showed that generally, output was negative and statistically significant ($\beta = -0.079$, $p < 0.10$) for the producers in the study area, output for male producers was also significant ($\beta = -0.095$, $p < 0.05$) and reduced profit accrued to them. The implication of this is that for 1% increase in the output of *S. biafrae* by the pooled and male producers, would reduce their profit by 7% and 10%, respectively. Cost of production was found to be negative and significant ($\beta = -0.068$, $p < 0.01$, and $\beta = -0.133$, $p < 0.01$) for pooled and female producers. The implication of this is that if cost of producing 1Kg of *S. biafrae* by the pooled and female producers increased by 1%, their profit will reduce by 7% and 13%, respectively.

The worth of waste for the pooled, male, and female producers was found to be negative and significant ($\beta = -0.354$, $p < 0.01$, $\beta = -0.351$, $p < 0.01$ and $\beta = -0.126$, $p < 0.10$). Meaning, for every one-naira worth of waste per 1kg of *S. biafrae*, the accrued profit would reduce by 35%, 35% and 13% for the pooled, male and female producers, respectively. Processing of these vegetables to other forms or product will reduce the loss as a result of wastage along the value chain.

In the inefficiency model, the estimated coefficient for age, level of education, household size and gender significantly (β = -0.016, p< 0.01, β = 0.072, p< 0.01, β = -0.090, p< 0.01 and β = -0.275, p< 0.01) influenced inefficiency of producers generally. While the age, household size and gender reduced inefficiency, the level of education increased it. This means that for one-unit increase in age, household size and gender, inefficiency will reduce by 2%, 9% and 3%, respectively.

More so, the negative coefficient of gender (male = 1 and female = 0) indicated that male producers were more profit efficient than their female counterparts in the business of *S. biafrae*. In the case of education, for one level increase in education, the inefficiency will increase by 7%. For the female producers, household size and vegetable farm distance influenced inefficiency significantly (β = -0.130, p< 0.10 and β = 0.068, p< 0.10) respectively. The implication of this is that one additional family member will reduce inefficiency by 13% and a one-kilometer increase in the vegetable farm distance will increase female inefficiency by 7%.

CONCLUSION AND RECOMMENDATION

The study aimed at analysing the profit efficiencies of selected Underutilised Indigenous Vegetables' producers for four UIVs to ascertain if their production is profit efficient or not. The study area was Oyo, Osun, Ondo and Ekiti States in Southwest Nigeria where NICANVEG project was initiated in year 2010. A multistage sampling technique was employed for selection of a representative sample of 188 UIVs producer. The data collected were analysed using Stochastic Frontier Profit Function.

In conclusion, a high profit efficiency levels found for the selected UIVs in the study is an ample sign that UIVs have the potential to generate higher household income, especially for women folks. As such, their production should be enhanced among male and female farmers. The quantity produced was found as an important variable which can reduce profit when it is increased and provision for processing and value addition are not in place. This is because UIVs are highly perishable in nature. Also, to maximise profit, best agricultural practices must be maintained to reduce cost of production to barest minimum.

This study therefore, proposes strategies such training of farmers on agricultural best practices to enhance farmers' knowledge and skills of farming, value addition and processing to mop up excess production and reduce waste. It also recommends that women should be encouraged to participate more in UIVs production to improve their livelihood.

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