EVALUATION OF GENDER DIFFERENCES IN RESOURCE UTILIZATION AND TECHNICAL EFFICIENCY OF IRRIGATED VEGETABLE FARMING IN PLATEAU STATE, NIGERIA

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ABSTRACT

The main thrust of the study was an appraisal of gender differences in resource utilization and efficiency of irrigated vegetable farming in Plateau State. Accordingly, two stage sampling technique was employed in selecting the respondents. Primary data for the study were collected using structured questionnaire administered to 156 male and 195 female randomly selected vegetable farmers during 2013 – 2014 production season. Data were analyzed using stochastic frontier production function and results of maximum likelihood estimates for the parameters of the stochastic production function showed that estimated coefficients of farm size, labour and fertilizer were significant at 1% for both male and female vegetable farmers. Seed and agrochemical were negative and significant at 1% for female farmers. The estimated input elasticities of production for farm size, labour, fertilizer and agrochemical are less than 1 for male and female farmers while agrochemical and volume of water were negative for female farmers. The returns-to-scale estimates for male farmers was 1.314 indicating increasing returns to scale while for the female farmers, was 0.97, which implies decreasing return to scale. The mean technical efficiency was 0.71 and 0.81 for the male and female farmers respectively. The study concludes that, the yield level in vegetable production among male and female farmers can be raised if the use of major variable inputs such as farm size, labour, seed and fertilizer influencing the output could be increased, vegetable production will remain a profitable enterprise. This study recommends that since positive and significant relationship exist between farm size, labour, seed and fertilizer, the Plateau State Agricultural Development Project should train the farmers on use of more resources utilization and farm management skills which will enable the farmers to maximally utilize their variable inputs focusing on efficiency as their goal.

Keywords: Gender, irrigation, resource utilization, technical efficiency, vegetable production.

BACKGROUND

The issue of gender differences in relation to farm productivity in subsistence farming has been of special interest from the standpoint of public policy in developing countries [see reviews by 1; 2; 3; 4]. The difference is usually viewed from the angle of human capital theory and measurement of discrimination. The role of rural women in agricultural development draws not only the attention of the academics but also the politicians and policy makers [5]. Thus the analysis of gender equality does matter for overall economic development and welfare measurement [6]. The topic of gender in agriculture has had an increasing interest for many researchers and investigators over the years and across the globe because of the debate on the role of women in economic development, as well as the double burden that they encounter from both housework and agricultural work [7; 8]. Thus the analysis of women participation in agricultural activities such as irrigated vegetable

production is important and cannot be over emphasized in their contribution to the Gross Domestic Product (GDP) [9].

Across Sub-Saharan Africa, several empirical studies have found that female farmers have lower yields than male farmers [10]. It has been established from studies that women are likely to have less land to cultivate than men, and when they do, tenure security may be weaker or totally unavailable [11; 12]. Secondly, their access to technology, information, and agricultural extension tends to be more limited compared to men [13]. In growing crops, women are more prone to be constrained in their access to inputs, resulting in lower levels of fertilizer, labour, and other inputs than is optimal [14; 12]. Management of the fields may reveal constraints as well, ranging from lower or poor levels of education to trying to play dual roles as farm owners and household managers [15]. The conventional method for analyzing and modelling differences in technical efficiency between men and women in agricultural productivity is through the estimation of production functions that model the maximum output produced from the set of inputs given the technology available to the household [16; 17; 18; 19].

The production of a farm manager in household j is given by equation (1): $Y_{ij}= f(V_i, X_i, Z_j)$, (1) where Y_{ij} is the quantity produced, V_i is a vector of inputs used by farm manager i (including land, labor, capital, and extension contact), X_i is a vector of individual attributes, and Z_j is household and community-level variable(s). This approach typically is implemented by pooling observations of male and female farmers to estimate a productivity outcome (yield or value of production) and normally includes a gender indicator as one of the control variables in X_i [20]. This production function approach focuses on technical efficiency, which assumes that men and women produce the same output and use the same technology, rather than allocative efficiency, which takes into account the distribution of household-level inputs among household members [21] and as revealed in the study by [22] on Burkina Faso and other similar work. This latter approach is increasingly important to determine not just how productivity differs by gender but why productivity differs, and it may better inform policies to increase agricultural productivity and incomes within marginalized groups.

A number of possible factors may be responsible for agricultural productivity differences between men and women in the developing world. First, assuming men and women have the same agricultural production function and use the same technique for the same crop, the quantity of inputs (e.g., fertilizer, seeds, or labor) utilised by men and women may differ. Second, the quality of inputs may differ. Land quality may differ between men and women, including, but not limited to, soil quality, topography, and proximity to access points such as water sources, roads, and housing [23]. Third, men and women may have different agricultural production functions, possibly because crop choice differs by gender, which may be influenced by cultural norms [24] or by other factors such as the lack of resources to cultivate specific crops and the culturally accepted division of labor. Fourth, even if both genders do have the same agricultural production function, shadow prices of inputs and credit may lead to the women's production frontier to lie beneath the men's frontier, implying that women are less productive [25; 26]. In a review of empirical evidence and methodology in gender analysis of agricultural productivity, [21] found that the majority of studies conducted from the mid-1980s to 1990s showed female farmers to be equally productive as their male counterparts once inputs and other background characteristics are controlled for.

Additional research has contributed to the debate surrounding gender and agricultural productivity, most existing studies used household headship as a gender indicator, again with

mixed findings. Three studies in Ethiopia found female-headed households have persistently lower productivity measures compared to their male-headed counterparts [27]. However, [5] discovered no significant productivity differences by gender of household head in The Gambia and Nepal, after controlling for other inputs. The objective of this study is to determine the gender differences in the resource utilization, efficiency and profitability of irrigated vegetable farming in Plateau State. Other specific objectives are to; describe the socio-economic characteristics of irrigated vegetable farmers by gender and; determine the gender differential in technical efficiency among the farmers in the study area.

Study Area

This study was conducted in four Local Government Areas of Plateau State, Nigeria. The State is one of the 36 States of Nigeria created on February 3, 1976. It is in the North Central geopolitical Zone of Nigeria and is located at the center of Nigeria, located between latitude 80^0 24^1N and longitude 80^0 32^1 and 100^0 38^1E of the Greenwich meridian. The State has 17 Local Government Areas and occupies a land area of about 30,913 Km^2 with a population of about 4,006,587 as at 2014 (estimation based on National Population Census, 2006) [28] given a growth rate of 2.7 [28]. Plateau State is located on an altitude ranging between 1,200 m to a peak of 1,829 m above sea level in Shere hills near Jos [29]. Plateau State shares boundaries with Kaduna, Nasarawa, Bauchi, Taraba, Gombe and Benue States. The Local Government Areas that served as study areas are: Barkin Ladi, Jos South, Jos East and Riyom.

Plateau State has long been associated with dry season irrigated vegetable production. The activity which was initially carried out on small plots by immigrant Hausa farmers from the Northern part of Nigeria who came to settle in the peri-urban regions of Jos using shaduf lift has witnessed a transformation in technology of using pumps to lift water [30]. Over the years, dry season vegetable farming experienced and continued to experience significant expansion both in terms of the number of farmers practicing it and the area of land under dry season irrigated vegetable production. The diversity of vegetable grown include tomato, carrot, lettuce, Irish potato, capsicum, radishes, spinach, beetroot, peas, pepper, garden egg, onion, leeks, celery and cauliflower [31]. The vegetables considered for this study are carrot, cabbage, green beans and green pepper since both categories of farmers cultivate the four vegetables.

METHODOLOGY
Sampling Procedure

A 2-stage sampling technique was employed in the selection of the respondents that were interviewed for this study [32]. In the first stage, four local government areas were purposively selected based on the level of involvement of women in vegetable farming in Plateau State (Information was obtained from the Plateau Agricultural Development Project [PADP]) Planning Office. Preliminary information gathered from the record available with the Planning Office of PADP showed that there were about 195 female and about 1,280 male farmers involved in vegetable production in the four local government areas. To obtain number of respondents for male farmers, 12% of 1,280 males were selected using simple random sampling method across the four LGAs. This is the second stage of the sampling procedure. A total of 351 vegetable farmers (male and female) served as respondents for the study.

Analytical Techniques

Stochastic frontier model which was originally proposed by [33] and have also been applied by researchers [34; 35; 36; 37], is expressed in general form as;

$y=g(x)e^{v}.e^{-u}$ .....(1)

$=g(x)\exp(vu)$……...(2)

Where:
y = observed output;
g(x) =conditional mean function of given input x;
v = a mean-zero error term that represents measurement error;
u = a firm-specific random effect that represent the firm's technical inefficiency.
In this study, the production technology for the vegetable is characterized by a Cobb-Douglas production function and expressed as:

$Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} \ . \ . \ . X_6^{\beta_6} e^{(v-u)}$ ....(3)

A logarithmic transformation provides a model which is linear in the log of the inputs and he nce easily used for econometric estimation [38; 34].

Cobb-Douglas production function for this study is defined by;

$\text{Log } Y = \beta_o+\beta_1 \log X_1+\beta_2 \log X_2 +\beta_3 \log X_3+\beta_4 \log X_4+\beta_5 \log X_5+\beta_6 \log X_6 V_i - U_i$…… (4)

Where;
Log = the natural logarithm
Y= Output of vegetables produced (kg)
X_1= Total amount of land area under vegetable production (hectares),
X_2= Labour (man days)
X_3= Seed/planting materials (kg)
X_4= Total amount of fertilizer used (Kg),
X_5= Agro Chemical use (litre) (Sarosite, Atraz 50FW and Bushfire)
X_6= Estimated water (litre) (25lit container used)
$\beta_1 - \beta_6$ = Parameters to be estimated,
β_o= Constant,
V_i = Random variable in production that cannot be influenced by the farmer,
U_i = Deviation from maximum potential output attributable to technical inefficiency.

RESULTS AND DISCUSSION
Socio-economic Characteristics of Respondents

Socio-economic characteristics are envisaged to influence farmers' production decision as well as their overall production efficiency. The socio-economic characteristics considered in this study are age, household size, marital status, farm size, years of farming experience, educational level, and membership of cooperative, extension contact, access to credit, and non-farm income.

Age Distribution of Vegetable Farmers

The results presented in Tab. 1 showed that the average ages of vegetable farmers were 43 and 39 years for male and female farmers respectively. These results imply that vegetable farmers in the study area were young and in their productive and active age group. The implication of this result is that there is likelihood of high productivity among vegetable farmers in the area since majority of the farmers are less than 50 years of age. Age is very important in agricultural production activities because it has a significant influence on the decision making process of farmers with respect to adoption of improved farming technologies and other production-related decisions [39]. It was earlier reported by [40; 41] that age of farmers has a positive effect on technical inefficiency because old people are less energetic and less receptive to agricultural innovations and hence develops inefficient production routines and practices.

Educational Level of the Farmers

As shown in Tab. 1, only 7.1 and 7.3% of male and female vegetable farmers respectively do not have formal education. These results imply that level of awareness and adoption of agricultural innovations among vegetable farmers would be very high. Literate farmers are expected to be more innovative because of their ability to obtain and comprehend information more quickly and their ability to take more risk. This position goes in line with the findings of [42] and [43] who all observed that educated farmers can obtain information from a wide range of sources, such as extension agents, electronic print media and internet, and also use their abilities to secure necessary inputs such as credit, insurance, payment methods, fertilizers and improved seeds for continuous agricultural productivity, profitability, and sustainability.

Farmers' Household Size

Distribution of the vegetable farmers by their household size (Tab. 1) indicates that majority of male (52.7%) and female (61%) had household size between 5 - 10 members. The average household sizes for the two groups were 8 and 7 members for male and female farmers respectively. These results imply that household sizes among vegetable farmers are large and there is no variation in terms of the household size of male and female farmers in the study area. The significance of household size in agriculture hinges on the fact that the availability of labour for farm activities, the total area dedicated to different crop enterprises, the amount of farm produce retained for domestic consumption, and the marketable surplus are all determined by the size of the farm household [44]. [38; 45], reported that family size was a significant variable which greatly influenced the technical efficiency of farmers.

Table 1. Distribution of the respondents according to their socio-economic characteristics

Socio-economic characteristics	Frequency		Percentage	
	Male	**Female**	**Male**	**Female**
Age				
21-30	10	37	6.3	18.9
31-40	52	81	33.4	41.7
41-50`	50	53	32.0	27.2
51-60	34	21	21.7	10.8
61-70	10	3	6.3	1.5
Total	**156**	**195**		
Level of education				
No formal education	11	15	7.1	7.7
Primary	37	46	23.7	23.3
Secondary	60	85	38.5	43.1
Tertiary University	31	33	19.9	17.6
Adult education	17	16	10.9	8.2
Total	**156**	**195**		
Household size				
1-5	48	60	30.7	30.7
6-10	82	119	52.7	61.0
11-15	20	15	12.8	7.7
16-20	6	1	3.8	0.5
Total	**156**	**195**		
Farming experience				
1-5	89	168	57.0	86.3
6-10	33	23	21.2	11.7
11-20	11	3	7.1	1.5
21-30	23	1	14.7	0.5
Total	**156**	**195**		
Farm size (Ha)				
0.1-1.0	122	162	78.2	83.2
1.1-2.0	28	30	17.9	15.4
2.1- 4.0	6	3	3.8	1.5
Total	**156**	**195**		
Number of extension visit				
No contact	96	158	61.5	81.0
1-3	56	34	35.9	17.5
4-6	2	2	1.2	1.0
6 and above	2	1	1.2	0.5
Total	**156**	**195**		
Amount of credit obtained (N)				
0	131	163	84.0	83.6
1000-20000	11	13	7.0	6.6
20001-40000	6	11	3.8	5.6
40001-60000	6	6	3.8	3.0
200000 and above	2	2	1.2	1.0
Total	**156**	**195**		
Membership of cooperative				
Non members	108	162	69.2	83.1
Members	48	33	30.8	16.9
Total	**156**	**195**		

Source: Field survey, 2014

Farming Experience among Vegetable Farmers

The results in Tab. 1 showed that majority of male (66.1%) and female (86.3%) farmers had between 1 - 10 years of farming experience. The average farming experience for men and women farmers were 10 and 7 years respectively. The significance of farming experience in agricultural production cannot be over-emphasized; this is because it determines farmers' ability to make effective farm management decisions, not only adhering to agronomic practices but also with respect to input combination or resource allocation. Experience is expected to influence farm production efficiencies because of accumulation of skills [46], noted that the longer a person stays on a particular job, the better his job performance tends to be. A study by [47] on productivity in food farming in northern area of Oyo State showed that year of farming experience increased agricultural productivity among farming households in Nigeria.

Distribution of Respondents Based on Farm Sizes

The distribution of the respondents by their farm size is shown in Tab. 1. The results revealed that more than three-quarter of male (78.2%) and female (83.2%) vegetable farmers had farm size of between 0.1 - 1.0 hectares. The average size of land for male and female farmers was 0.84 and 0.45 hectares respectively. This result revealed that female farmers had less access to farmland. The maximum farm sizes of 5 and 4 hectares cultivated by the farmers in the study area implied that vegetable farmers are basically small scale farmers based on reported classification of small-scale farms to be between 0.1 hectares and 5.9 hectares [48]. Lack of access to land remains a major constrain for women farmers in Africa and land reform programmes have led almost exclusively to the transfer of land rights to male heads of households [49].

Distribution of Respondents Based on Extension Contact

The result of extension contact by the farmers in Tab. 1 indicates that majority of male (61.5%) and female (81%) vegetable farmers have not had access to extension contact. This implied that more than half of the farmers in the area do not have access to extension contacts which is the main source of information on improved farm practices. Limited extension contact may reduce farmers' access to information on improved farm technologies. Contact with extension personnel can lead to improvement in food production as a result of information on improved agricultural technologies which will enhance production efficiency. Higher extension contacts have been reported to result in increased adoption of improved farm production technologies and they further stressed that the frequency of extension contact is very essential as it guides the farmers from awareness to the adoption stage [50].

Amount of Credit Obtained by Vegetable Farmers

As shown in Tab. 1, more than three quarter of male (84%) and female (83.6%) do not have access to credit. The average credit received by male and female vegetable farmers was N6903.85 and N5273.33 respectively. This was similar to result of [43]; they noted that 76% of their respondents had no access to financial aids, while only 24% do. Similar work on gender studies also noted limited access to credit by the farmers especially women farmers as noted by [51].

Membership of Cooperatives

The results in Tab. 1, show the distribution of the respondents by their participation in cooperative. It was found that majority of male (69.2%) and female (83.1%) do not belong to cooperative. Membership of cooperative could assist farmers in the aspect of information sharing. It enables farmers to interact with other farmers, share their experiences and assist themselves. [52], found that membership of cooperatives enabled women to acquire more land compared to those who were not members. It could enhance the accessibility of farmers to credit facility and serve as a medium for exchange of ideas that can improve their farm activities [53].

Distribution of Farmers Based on Non-farm Income

As shown in Tab. 1, majority of male (61.5%) and female (69.7%) do not have non-farming income. This implied that the primary occupation of the farmer in the study area is farming. Farmers earn their income through farming activities. According to [54], employment in non-farm activities is essential for diversification of the sources of farm household's livelihood. It enables households to modernize their production by giving them an opportunity to apply the necessary inputs and reducing the food shortage during the period of unexpected crop failures.

Maximum likelihood Estimates in Vegetable Production

The result of Maximum Likelihood Estimates (MLE) for the production frontier is presented in Tab. 2. The estimated parameters of sigma-squared are 0.949 and 0.706 for male and female vegetable farmers respectively. These values were significantly different from zero at 1% of probability which is indicating a good fit and the correctness of the specified distributional assumption of the composite error term. The generalized likelihood ratio statistics of 4.0 was obtained for male farmers while 14.6 was obtained for female vegetable farmers. These ratios exceed the critical chi-square values at 1% level of significance. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model. Thus, the functional form that is, Cobb-Douglas used in this estimation is an adequate representation of the data. It was further revealed that the values of the gamma statistics were 0.75 and 0.84 for male and female farmers respectively. These indicate that 75% and 84% of the changes in the output of vegetable are attributable to farmers' inefficiency factors. The result revealed that technical inefficiency effects were present in vegetable production in the study area. Hence, the hypothesis that the parameter estimate of gamma equals zero is strongly rejected.

Farm Size

The result revealed that the coefficient of farm size for male (0.611) and female (0.374) were positive and significant at 1% level of probability (Tab. 2). This indicates that increase in size of land under vegetable production will increase the output level. The implication of this is that availability of land greatly influenced vegetable production for the two groups of farmers. It was observed that the production of vegetable in the study area is subsistent therefore land as an input has major influence on output. This result is consistent with the findings of [55] who found out that increasing farm size is expected to increase crop output of Fadama farmers in Northern Nigeria.

Table 2: Maximum likelihood estimates of stochastic frontier production for Vegetable production

Variable coefficient						
	Male			Female		
Variable	**Coefficient**	**Std. Error**	**t-value**	**Coefficient**	**Std. Error**	**t-value**
Constant (β_0)	5.609	0.962	5.83***	2.944	0.822	3.58***
Farm size (X_1)	0.611	0.146	4.18***	0.374	0.133	2.82***
Labour (X_2)	0.514	0.126	4.09***	0.348	0.099	3.52***
Seed (X_3)	-0.071	0.061	-1.16	-0.127	0.046	-2.77***
Fertilizer (X_4)	0.331	0.083	3.98***	0.651	0.060	10.81***
Agro chemicals (X_5)	0.050	0.079	0.63	-0.273	0.053	5.18***
Water (X_6)	-0.121	0.083	-1.45	-0.001	0.050	-0.02
Variance parameters						
Sigma squared (σ^2)	0.949	0.201	4.72***	0.706	0.072	9.81***
Gamma (γ)	0.752	0.088	8.54***	0.840	0.420	2.00**
LR test	4.40			14.07		
log likelihood function	-211.43			-242.81		

$\sigma^2 = \sigma_v^2 + \sigma_u^2, \gamma = \sigma_u^2 / \sigma^2$, Std. - Standard
***** Significant at 1%, ** Significant at 5%.**

Labour

The coefficient (0.514) of labour for male farmers and female (0.348) were positive and statistically significant at 1% level. This implies that labour positively influences the output of vegetable. The implication of this is that vegetable output would increase if farmers in the study area increase the use of labour. The results indicate that a unit increase in the amount of labour would increase vegetable production among male and female by 0.514 and 0.348 units respectively.

Seed

The coefficient of seed for male (-0.071) and female (-0.127) were negative but only significant among female farmers. This implied that more seed were utilized under vegetable production and increase in the use of seed will decrease the output level. The overutilization of seed could be attributed to the type of seed used by the farmers which is predominantly from previous harvest and seed purchase from open market and also to the fact that there seem to exist non consciousness of seed cost especially by the female farmers.

Fertilizer

The estimated coefficient of fertilizer for male (0.331) and female (0.651) vegetable farmers were positive and significant at 1% level of probability. This implies that fertilizer exerts positive influence on vegetable production among the two groups of farmers indicating that as more fertilizer is being used the output of vegetable would increase.

Agrochemical

The coefficient of agrochemical was negatively related to the output of vegetable among female (-0.273) farmers while on the contrary it was positive among male (0.050) farmers.

This implied that increase in the use of agrochemical would decrease output level among female vegetable farmers and vice versa meaning female farmers were over-utilizing agrochemicals on their farms.

Water

The coefficient of water used by the two groups of farmers was found to be negative. However, it was not significantly related to the output level. This could be attributed to availability of water and none compliance to water requirement of the crops by both groups of farmers.

CONCLUSION

It was found that the yield level in vegetable production among male and female farmers can be raised if the use of major variable inputs such as farm size, labour, seed and fertilizer influencing the output could be increased. Vegetable production is a profitable enterprise among male and female farmers. However, the sum of the partial output elasticities with respect to all inputs indicates increasing returns to scale vegetable production among the male farmers. The implication is that a proportional increase in all the factors of production leads to a more than proportional increase in output. On the other hand, female farmers were found producing at stage two of production which is the rational stage for profit maximization.

RECOMMENDATIONS

Based on the findings of this study the following recommendations are made:
It was observed that the positive and significant relationship between farm size, labour, seed and fertilizer imply that increasing the levels of utilization of each of these inputs will result in an increase in the level of vegetable output. The Plateau State Agricultural Development Agency and other relevant agricultural based capacity development organizations that have the mandate of training to embark on robust training of farmers in the study area through extension agents and non-governmental agricultural development organizations on resource (farm size, fertilizer, labour and seeds) utilization and farm management skills which will enable the farmers to maximally utilize their variable inputs focusing on efficiency as their goal. Extension agents working with the Plateau Agricultural Development Project should have the vegetable farmers in the project areas on the schedule for visits and contact to enable the farmers have adequate access to information on vegetable production innovations, disease and pest control measures developed by research institutions, price information among other issues of interest to the vegetable farmers. Vegetable farmers should organise themselves into credit relieving societies so as to pool their resources together, increase their access to fund and overcome liquidity constraints that can limit their accessibility to resources in vegetable production.

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