Gender Differentials on Productivity of Rice Farmers in South-western Nigeria: An Oaxaca-blinder Decomposition Approach

Temitope Oluwaseun Ojo (ojotemitope70@yahoo.com)
University of KwaZulu-Natal School of Agricultural Earth and Environmental Sciences
https://orcid.org/0000-0002-3517-0435
Lloyd J. S. Baiyegunhi
University of KwaZulu-Natal School of Agricultural Earth and Environmental Sciences
Gideon Danso-Abbeam
University of development studies, Tamale, Ghana
Abiodun A Ogundeji
University of the Free State

Research

Keywords: Gender, rice productivity, Oaxaca-Blinder approach, Nigeria

Posted Date: July 21st, 2020

DOI: https://doi.org/10.21203/rs.3.rs-42419/v1

Gender differentials on productivity of rice farmers in south-western Nigeria: An Oaxaca-Blinder decomposition approach

Temitope. O Ojo[a]*, Lloyd J. S. Baiyegunhi[c], Gideon Danso-Abbeam[d] and Abiodun. A Ogundeji[e]

[a]*Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife, Nigeria*

[b]*Disaster Management Training and Education Centre for Africa at the University of the Free State P.O Box 339 Bloemfontein 9300 South Africa.*

[c]*Department of Agricultural Economics, University of KwaZulu-Natal, South Africa*

[d]*Department of Agricultural and Resource Economics, University for Development Studies, Tamale, Ghana*

[e]*Department of Agricultural Economics, University of the Free State, Bloemfontein, South Africa*

**Corresponding author email: ojotemitope70@yahoo.com*

Abstract

One of the critical constraints hindering the transformation of African agriculture in general, and Nigerian agriculture in particular, is gender disparities in productivity. This study, therefore, examines gender inequality in farm productivity and sources of the productivity differentials among rice farmers in Nigeria, using the Oaxaca-Blinder (OB) gender decomposition model. The results revealed an uneven situation between men and women, leading to a gender productivity gap of about 29% in favour of men. Thus, female-managed plots are 29% less productive than male-managed plots. The decomposition of the sources of gender productivity differences shows that marital status, education, farm size and access to market information are the significant determinants of the endowment factor that contribute to about 15% of the productivity gap. The study, therefore, concludes that gender productivity inequalities exist in the Nigerian agricultural sector, hence, paying attention to these productivity gaps and factors contributing to these gaps is crucial in formulating policy interventions oriented towards women empowerment.

Keywords: Gender; rice productivity; Oaxaca-Blinder approach; Nigeria

1 Introduction

Agricultural production risks are dominant in developing nations. Most farmers in these countries experience such risks, even though the major origin and implications thereof may differ across nations (Hammer et al., 2014). Agricultural production activities in Africa, as opined by Kurukulasuriya and Mendelsohn (2008) and supported by Adimassu, Kessler and Stroosnijder (2014), are mainly more susceptible to climate change in comparison with other socioeconomic factors. Smallholder farmers in sub-Saharan Africa (SSA) are likely to be more susceptible to production risks, most of them especially due to increasing incidences of poverty, inadequate technological advancement and over-reliance on rain-fed agriculture (Mulwa, Marenya & Kassie, 2017). In the said regions, people remain largely dependent on agricultural productivity and other natural-resource-based strategies that are vulnerable to risks (Iiyama et al., 2008; Call, Gray & Jagger, 2019).

Rice is one of the most important food crops, being a staple food for about half of the world's population (Fageria & Baligar, 2003). Rice production has to be increased by about 60% to meet dietary needs and match the explosive increase in world population by the year 2025 (Fageria, Moreira & Coelho, 2011). Rice productivity is generally low in the sub-Saharan African countries where most farmers are smallholders, and even lower for female farmers when compared to their male counterparts. Studies have persistently identified a gap of 20% to 30% in agricultural productivity to the disadvantage of women, being an important barrier in terms of the development of the agricultural sector in this region. One of the most enduring myths about gender, as posited by Doss et al. (2018), is that 70% of the world's poor are women. However, it is documented that women, including girls worldwide, are disadvantaged in terms of human capital development, physical capital such as land and assets, earnings and productivity gaps relative to men, and in terms of voice in their households and society (World Bank, 2011). Women are further disadvantaged by being excluded from participating in decision-making in some programmes which involve agricultural policies that aim to promote food security and food production in the country (Ogunlela & Mukhtar, 2009). Among other factors, the socioeconomic characteristics of farmers attribute to affecting women’s participation in decision-making in agriculture. Since women constitute an integral part of the production process, their exclusion or minimal involvement in decision-making affects the formulation of effective policies that are meant to tackle farmers’ problems.

As asserted by Kilic et al. (2015), gender differences in agricultural productivity across SSA ranged widely from 4% to 40% and the major reasons for the observed gender gap were due to differences in the use of agricultural inputs; tenure security and related investments in land and improved technologies; market and credit access; human and physical capital; and institutional and cultural constraints affecting intra-household assignments of farm/plot management and marketing duties. As a result of this gender gap, rice farmers are not getting maximum returns from resources used in production, which leads to a decline in per capita food production and a low self-sufficiency ratio (Global Rice Science Partnership, 2013).

Therefore, a crucial need exists for information on gender differentials in productivity of smallholder rice farmers. According to Shah and Kulkarni (2008), the discourse on gender roles and needs, the capabilities to manage and access, and the control over agricultural productivity provide a nuanced understanding of the agricultural gender research interface in the context of developing countries. The different gender roles and activities affect the environment differently and have a different impact on gender. Men's and women's different use of productive inputs explain the inefficient intra-household allocation (Goldstein and Udry, 2008), as well as cultural, political and socioeconomic factors (Peterman et al., 2014; Aguilar et al., 2015). Poor women are generally on the receiving end of the effects of increasing environmental degradation and depletion of natural resources, because of their involvement in and reliance on livelihood activities which depend directly on the natural environment. Rice, being an important crop, gained prominence in several studies in Nigeria. Previous studies had focused on the adoption of an improved rice variety (Awotide et al., 2013); the impact of credit demand on rice productivity (Ojo et al., 2019); the consumption and marketing of rice (Adeyeye et al., 2010; Bamidele, Abayomi & Esther, 2010); while other studies focused on resource-use efficiency (Amaechina & Eboh, 2017) and technical efficiency (Ayinde et al., 2009 Kadiri et al., 2014). These studies had been conducted in various regions of Nigeria, however, there is a dearth of information on gender differentials in productivity of rice farmers in South-West Nigeria. Conversely, this study examined the gender differential in the productivity of smallholder rice farmers in South-West Nigeria. As a caveat for this study, an Oaxaca (1973) and Blinder (1973) decomposition method of the wage gender gap was employed to decompose the productivity gap between average male and female smallholder rice farmers. Presumably, this study is the first to use the Oaxaca-Blinder (OB) decomposition approach to decompose the productivity gap between male and female smallholder farmers in Nigeria. By identifying the drivers of the gender gap as well as examining the implications of women's role within households for agricultural productivity from a policy perspective, this study follows Quisumbing and Pandolfelli (2010) and Aguilar et al. (2015) to provide a tool for the design of more effective interventions. The study also adds to the body of existing literature on gender differences in agricultural productivity by updating the evidence on productivity gaps and resolving some of these confines.

2 Gender and agricultural productivity

Gender difference in farm productivity in subsistence farming had become an issue of discourse in public policy in developing countries (Dossah & Mohammed, 2016). Determining the productivity level of both male and female farmers is significant in enhancing food security in Africa where there is high disparity in cultural and religious beliefs. The widened gender gap in adopting modern crop varieties and other agricultural technologies is detrimental to the empowerment of women in developing countries, and imposes real costs on societies in terms of untapped potential in agricultural output, food security and economic growth (Ragasa, 2012). Empirical studies had indicated that, if women farmers had the same access as men to improved agricultural inputs such as fertilizer and seed, maize yields would increase by as much as 16% in Malawi, 17% in Ghana and 19% in western Kenya (Diiro et al., 2018). Addison, Ohene-Yankyera and Fredua-Antoh (2016) reported that female farmers are more productive than male rice farmers in Ghana. This finding is also in consonance with the study of Due and Gladwin (1991) who observed that inefficiency of women rice farmers was due to constraints in accessing productive inputs. To the contrary, in a similar study, Omondi and Shikuku (2013) provided evidence that male farmers are more efficient than female rice farmers in Kenya. Kinkingninhoun-Mêdagbé et al. (2010) observed a significant difference in paddy rice yield of men and women farmers in Benin, disclosing a larger yield by male farmers, although it revealed that there was no significant difference in technical efficiency of men and women farmers. They explained that the higher productivity of male farmers as opposed to their female counterparts was due to the possession of larger land holding sizes allocated for rice farming by male farmers. Furthermore, research in developing countries showed that income controlled by women has a greater positive effect than income controlled by men in terms of calorie intake, nutrition, health and educational attainment of household members (Quisumbing et al., 1995). While measuring the gender gap in the adoption of modern maize and investigating how Malawi's Farm Input Subsidy Program (FISP) impacted on the gap, Fisher and Kandiwa (2014) found contrary results as compared to previous studies by Chirwa (2005) and Smale (2011), which revealed that gender was an important determinant of modern maize adoption, even after having controlled for individual, household and community-level characteristics. Their studies posited that FISP coupon use was associated with an overall increase of 22.2% in the probability of modern maize adoption for female household heads, but did not impact on the adoption probability of wives in male households.

2.1 Conceptual framework

Following the classical approach of the wage gender gap literature of Oaxaca (1973) and Blinder (1973), an OB decomposition methodology was employed by dividing the productivity gap between the average male and female farmer into two components: (i) the endowment effect and (ii) the structural effect. The former is accounted for by unequal access to production inputs and farmer characteristics, while the latter is associated to gender differences in the returns to such factors. Since this method builds on basic OLS regression estimates, the problem of endogeneity is inevitable in production inputs as found in most other studies (Peterman et al., 2011; Quisumbing, 1996).

Various decomposition methods had been extensively employed in the gender and union wage gap literature. They had also been used to understand which factors explain changes in inequality and account for economic growth (Fortin, Lemieux & Firpo, 2011). In evaluating the decomposition of gender differentials in agricultural productivity in Ethiopia, Aguilar et al. (2015) suggested in their study that differences in the returns to extension services, land certification, land extension and product diversification may contribute to the unexplained fraction of smallholder farmers' productivity in Ethiopia. This article adopts a decomposition method to determine to what extent differences in levels and returns to productivity determinants explain the overall gender differential in agricultural productivity. The main purpose of the decomposition method is to partition the overall difference of a given distribution's statistic of interest between two groups:

$$\Delta_o^u = u\left(F_{Y_B/Z_B}\right) - u\left(F_{Y_A/Z_A}\right) \quad (5)$$

where $u(\cdot)$ is the statistic in which $v\ (\cdot)$ is the statistic of interest, usually the mean, and F_{Y_B/Z_B} is the cumulative distribution of the potential outcome, Y_{qi}, for individuals of group S. In this article, the mutually exclusive groups are male and female smallholder rice farmers. To be able to construct counterfactuals, a structural form relating to the outcome with observed and unobserved individual characteristics (X_i and ε_i, respectively) is specified. Making simple counterfactual treatment, overlapping support, and ignorability assumptions, the overall difference, Δ_o^u, in Equation 5 can be split into two terms after adding and subtracting $u\left(F_{Y_A/Z_A}\right)$ from Equation 5:

$$\Delta_o^u = \underbrace{\left(u(F_{Y_B/Z_B}) - u(F_{Y_A^C/Z_B})\right)}_{\Delta_s^u} + \underbrace{\left(u(F_{Y_A^C/Z_B}) - u(F_{Y_A/Z_A})\right)}_{\Delta_X^u} \tag{6}$$

where Δ_s^u or the "structural effect" (also called the unexplained effect) represents differences in returns to observable characteristics, and Δ_X^u or the "endowment effect" reflects differences in the distribution of observable characteristics between both groups.

The basic mean decomposition follows the method developed by Oaxaca (1973) and Blinder (1973), which allows the estimation of Equation 6 by imposing the following additional assumptions:

Additive linearity implies that the structural form can be represented by a linear additively separable function of individuals' observed and unobserved characteristics:

$$Y_{qi} = X_i\alpha_q + u_{iq} \quad \text{where } q = (A,B) \text{ and } u_{iq} = k_q(\varepsilon_i) \tag{7}$$

where X_i is a vector of characteristics and α_q is a vector of OLS coefficients, estimated separately for each group.

Zero conditional mean indicates that $\mathrm{E}(u_{iq}/X_{i,}Z_{Bi}) = 0$

Applying assumptions 1 and 2 to the OB framework is obtained as:

$$\Delta_o^u = \left(u(F_{Y_B/Z_B}) - u(F_{Y_A^C/Z_B})\right) + \left(u(F_{Y_A^C/Z_B}) - u(F_{Y_A/Z_A})\right)$$

$$= \mathrm{E}(X_{i,}/Z_{Bi})(\alpha_B - \alpha_A) + \mathrm{E}(X_{i,}/Z_{Ai})(\alpha_B - \alpha_A)$$

$$= \underbrace{\mathrm{E}(X_{i,}/Z_{Bi})(\alpha_B - \alpha^*) + \mathrm{E}(X_{i,}/Z_{Ai})(\alpha^* - \alpha_A)}_{\Delta_S^U} + \underbrace{\left(\mathrm{E}(X_{i,}/Z_{Bi}) - \mathrm{E}(X_{i,}/Z_{Ai})\right)\alpha^*}_{\Delta_X^U} \tag{8}$$

where, in the last step, $\mathrm{E}(X_{i,}/Z_{Bi})\alpha^*$ and $\mathrm{E}(X_{i,}/Z_{Ai})\alpha^*$ are added and subtracted to derive at an alternative measure for the structural effect. The structural effect, Δ_s^u, is thus the sum of two terms: male structural advantage, $\mathrm{E}(X_{i,}/Z_{Bi})(\alpha_B - \alpha^*)$, and female structural disadvantage, $\mathrm{E}(X_{i,}/Z_{Ai})(\alpha^* - \alpha_A)$. To the extent that the additive linearity assumption is satisfied, a detailed decomposition assessing the contribution of each covariate to the structural and endowment effects can be estimated.

It was assumed that agricultural productivity is a function of the manager’s socio-demographic factors, labour and non-labour inputs, and farm size. Following a yield-based approach, this study’s regression analysis expresses these covariates as inputs per unit of land (Quisumbing, 1996). Although this specification may suffer from an endogeneity problem (Peterman et al., 2011; Quisumbing, 1996), the objective of this study is not to infer causality, but to identify to what extent differences in the observed variables explain the gender gap in productivity and to inform policy by highlighting possible areas of intervention. Bias in the estimates may arise if the ignorability assumption is not valid and, to test for this, a set of robustness checks was performed, although it was still possible that they may arise from other, unobservable terms.

3 Study area and source of data

The study was carried out in the south-western part of Nigeria, consisting of the Lagos, Ogun, Oyo, Osun, Ondo and Ekiti states, collectively known as the South-West geographical zone of Nigeria. The area lies between the longitudes 2°31’E and 6°00’E and the latitudes 6°21’N and 8°37’N, and covers a total land area of about 77,818 km^2. It is bounded in the east by the Edo and Delta states, in the north by the Kwara and Kogi states, in the west by the Republic of Benin, and in the south by the Gulf of Guinea. The climate of South-West Nigeria is tropical in nature and characterized by wet and dry seasons. The mean temperature ranges between 21°C and 34°C, while the annual rainfall ranges between 150 mm and 3000 mm. The wet season is associated with the south-western monsoon wind from the Atlantic Ocean, while the dry season is associated with the north-eastern trade wind from the Sahara desert. The vegetation in South-West Nigeria is made up of fresh water swamp and mangrove forest at the belt, the low land in forest stretching inland to the Ogun and part of the Ondo states, with the secondary forest stretching towards the northern boundary by the derived and southern Guinea savannas (Agboola, 1979).

A multistage sampling technique was used to select the respondents for the study. The first stage involved a typical case purposive selection of three states, Ekiti, Ondo and Osun, located in the same agro-ecological area. In the second stage, four local government areas (LGAs) were selected from each state, based on the predominance of smallholder rice farmers in these areas and using a typical case purposive sampling. In the third stage, five villages were randomly selected from each of the four LGAs. Following Tesfahunegn et al. (2016), the sample size for the study was determined at 95% confidence level and 5% margin of error, using the sample determination formula as described by Cochran (1977) and allowing for six smallholder rice farmers to be selected from each of the five villages earlier selected. This produced 360 respondents interviewed for the study. Data was collected by means of a pre-tested, well-structured questionnaire on respondents' socioeconomic characteristics as well as the productivity of rice.

4 Empirical results and discussions

The descriptive statistics of the surveyed rice farmers are presented in Table 1. The standard OB decomposition technique was applied here to divide the productivity gap between men and women with respect to farm plot management into a part that is explained by differences in the factors influencing productivity and the parts that cannot be explained by those factors. The results of the group-specific regression for males and females are presented in Table 2. The main determinants of productivity differences include age, marital status, formal education, and farming experience.

Table 1: Definitions and summary statistics of variables used in the model

Variables			
Dependent	***Description of variables***	***Mean***	***SD***
Rice yield	Log of rice yield (kg)		
Explanatory variables			
Gender	1 if household (HH) head is male, 0 if female	0.56	0.50
Age of HH head	Age of HH head (years)	47.28	7.67
Marital status	1 if HH head is married, 0 if other/single/widowed	0.80	0.40
Educational status	Years of education of HH head	6.45	5.70
Household size	Number of HH size	4.66	1.24
Off-farm income	1 = if HH engages in any off-farm activity	0.54	0.50
Farming experience	Years of HH experience in rice production	15.73	5.09
Access to credit	1 if HH has access to credit, 0 if otherwise	0.57	0.50
Farm size	Total land owned by HH, in hectares	7.37	3.04
Access to climate info	1 if HH gets climate change information, 0 if otherwise	0.36	0.48
Access to ext. contacts	1 if HH has access to extension, 0 if otherwise	0.53	0.50
Membership	1 if HH belongs to Farmers' Association	0.54	0.50
Location_Ekiti State	1 if HH is from Ekiti, 0 if otherwise	0.38	0.48
Location_Ondo State	1 if HH is from Ondo, 0 if otherwise	0.38	0.49
Location_Osun State	1 if HH is from Osun, 0 if otherwise	0.35	0.48

SD denotes standard deviation.

4.1 Descriptive statistics of socioeconomic variables

The results in Table 1 show that household heads' average age and years of education are 47 and six years, respectively. With regard to extension access, about 53% of the respondents have contact with extension agents. Access to credit is a major determinant in agricultural productivity, but only about 57% of smallholder rice farmers have access to credit. However, there are clear variations in terms of access to information, for example, about 36% of farmers who at least adopted a strategy has access to information related to agricultural production. The average farming experience of farmers in the study area is 15 years. The result is in agreement with Hitayezu, Okello and Gor (2010), who posited that farmers' perception and efficient response to the economic conditions is directly related to their resource allocation ability, which is subsequently linked to their human capital endowment.

Table 2: Gender-specific farm productivity models – estimates from the Oaxaca-Blinder (OB) decomposition

Variable	***Male-managed plot***		***Female-managed plot***	
	Coeff.	***SE***	***Coeff.***	***SE***
Socioeconomic characteristics				
Age	0.0066	0.0039[c]	0.0050	**0.0027**[c]
Marital status	-0.0293	0.0848	-0.2269	**0.0569**[a]
Formal education	-0.2397	0.1347[c]	-0.2995	**0.0857**[c]
Household size	0.0024	0.0244	-0.0134	0.0143
Farming experience	-0.0227	0.0159	-0.0186	**0.0104**[c]
Farm size allocated to rice farming	0.0874	0.0111[a]	0.1189	**0.0073**[a]
Engagement in non-farm activities	0.3589	0.4288	-0.0352	0.1171
Institutional characteristics				
Access to extension services	-0.0190	0.2206	0.0112	0.0955
Access to market information	0.0229	0.0828	-0.0704	0.0461
Membership of farmer-based organization (FBO)	-0.2562	0.3778	-0.0019	0.1144
Access to credit facility	0.0754	0.0786	0.0543	0.0454
Constant	8.5950	0.3841	9.0401	0.2926
Number of observations	159		201	
F (11, 147/189); Prob > F	0.0000		0.0000	
R-squared	0.4254		0.7110	
Adjusted-squared	0.3824		0.6942	

Coeff. and SE denote coefficient and standard error, respectively. a and c denote significance levels at 1% and 10%, respectively.

4.2 Empirical discussions

Age has a positive effect on productivity and affects both male and female plot managers. However, age has a marginally higher private rate of return for males than for females. This could be attributed to the biological make-up and roles of women, coupled with the tedious nature of their role as administrator of the house. The said biological make-up and roles refer to the fact that women give birth and breast-feed children, which naturally weaken them. In addition, women in African society perform all the household chores and farming activities, which potentially make them weak. As a result, their strength to work hard for higher productivity declines as they age. Moreover, some of these old women may be widowed, leading to less financial muscle and support than that of their male counterparts to purchase farm inputs required for higher productivity.

Marital status has no influence on male managers but a negative significant effect on female managers. Thus, marital status has a lower private rate of return for women who manage their own farm plots. As indicated by Saito, Mekonnen & Spurling (1994), Tiruneh et al. (2001) and Aguilar et al. (2015), female-headed households are, in most cases, a result of single women, or women having being divorced or widowed. In Nigerian rural farming communities, women managers' role depends on their position in the society. Widows and divorced women are usually marginalized in terms of access to resources. A limitation in their access to resources makes them significantly less productive in contrast with their married counterparts (Fafchamps & Quisumbing 2002; Aguilar et al. 2015).

Surprisingly, productivity will decrease for both male and female plot managers as the number of their years in formal education increases. The negative effect of education on productivity could reflect insufficient information or inadequate field training to address low agricultural productivity in SSA in general, and Nigeria in particular. In the same vein, farming experience displays negative returns for female and male plot managers. Finally, there is a positive and significant relationship between farm size allocated to the production of rice and the productivity of both genders. This result is inconsistent with evidence available in the literature (Benjamin 1995; Barret 1996; Eastwood, Lipton & Newell, 2010; Aguilar et al. 2015) which documents a negative relationship between farm size and productivity. However, it has higher returns for women than for men. This occurs because men usually manage bigger areas of a land which may result in diminishing marginal returns to productivity and, hence, deliver a lower private rate of return in comparison with their female counterparts.

4.3 Oaxaca-Blinder (OB) mean decomposition

As mentioned above, the mean difference in farm productivity between male and female is based on the Oaxaca (1973) and Blinder (1973) decomposition approach. In Table 3, the decomposition output reports the mean predictions for male and female and the difference between the two. In the Table, the mean value of productivity reflects 9.36 for men and 9.08 for women, leading to a significant gap difference of 0.29. This suggests an uneven situation between men and women regarding farm productivity. Thus, women are about 29% less productive than their male counterparts. The magnitude of this gap is not much different from those obtained in other African countries. A study in Malawi by Kilic, Palacios-Lopez and Goldstein (2013) obtained a gender gap of 25.4%, in Ethiopia, Aguilar et al. (2015) indicated gender difference of about 23.4%, while in Niger, Backiny-Yetna and McGee (2014) found a gender productivity differential of about 18.3%. Moreover, a recent study by Mukasa and Salami (2015) on gender productivity differentials across three African countries found productivity gaps of 18.6%, 27.4% and 30.6% for Nigeria, Tanzania and Uganda, respectively. The endowment effects reflect the mean increase in women's productivity if they bear similar characteristics as men. The endowment factor further suggests that, if women had the same productivity characteristics as their male counterparts, their productivity would have been 0.043 (4.3%) higher. This increase implies that differences in endowment account for only about 15% of the productivity gap. It is, therefore, not surprising that the endowment factor is not significant, even at a 10% level of significance. The coefficient factor (structural effect) quantifies the change in female's productivity when male's coefficients are applied to female's characteristics. Thus, if society provides equal opportunities for both men and women, women's productivity would increase by a substantial 28%.

Table 3: Oaxaca-Blinder (OB) decomposition estimates

Log productivity	*Coefficient*	*Standard error*
Mean value for male	9.364[a]	0.037
Mean value for female	9.078[a]	0.319
Mean difference	0.286[a]	0.049
Decomposition		
Endowments	0.043	0.0424
Coefficient	0.279[a]	0.038
Interaction	0.488[b]	0.023

[a] and [b] denote significance level at 1% and 5%, respectively.

The structural effect explains about 98% of the productivity gap. These findings are in line with the study of Aguilar et al. (2015) but differ from the findings of previous studies (Alene et al., 2008; Kinkingninhoun-Mêdagbé et al., 2010; Kilic, Palacios-Lopez & Goldstein, 2014; Vargas and Vigneri, 2014) which state that gender inequalities in farm productivity are mostly explained by differences in production characteristics. The interaction term is a measure of the simultaneous effects of differences between endowment and coefficient.

After the decomposition of the farm productivity gap into endowment and structural effects, the study boosts the analysis by identifying factors contributing to these two effects. As stated earlier, if the additive linearity assumption is satisfied, a detailed decomposition of the determinants of endowment and structural effects can be estimated. Table 4 presents the results of the detailed decomposition of the same variables mentioned in Table 1.

Table 4: Detailed decomposition of endowment and structural effects

Variables	***Endowment effects***		***Structural effects***	
	Coeff.	***SE***	***Coeff.***	***SE***
Socioeconomic characteristics				
Age	0.0029	0.0018	-0.0770	0.2223
Marital status	-0.0221	0.0058[a]	-0.1479	0.0764[b]
Formal education	-0.0152	0.0034[a]	-0.0339	0.0904
Household size	-0.0012	0.0014	-0.0731	0.1305
Farming experience	0.0078	0.0056	0.0747	0.3447
Farm size allocated to rice farming	-0.0139	0.0005[a]	0.2346	0.0989[b]
Engagement in non-farm activities	-0.0018	0.0033	-0.2032	0.2292
Institutional characteristics				
Access to extension services	0.0003	0.0002	0.0150	0.1194
Access to market information	-0.0046	0.0012[a]	-0.0305	0.0310
Membership of FBO	0.0005	0.0035	0.1327	0.2061
Access to credit facility	0.0052	0.0037	-0.0084	0.0360

Coeff. and SE denote coefficient and standard error, respectively. [a] and [b] denote significance levels at 1% and 5%, respectively.

The results from the detailed decomposition indicate that variables such as marital status, education, farm size and access to market information contribute to endowment effects. From the descriptive statistics (Table 1), about 75% of the women in the data sample are married compared to about 85% of the men. Thus, approximately 25% of the women is made up of divorced, widowed and unmarried (never married before) females in comparison with the approximate 15% of men with similar statuses. However, these proportions are not substantial enough to cause a significant difference. Another important contributor to the endowment effect is the size of farmland allocated to the production of rice. The results in Table 4 indicate no significant difference in the land size allocated by both men and women to rice production. This is contrary to many examples in the literature (Pender & Fafchamps, 2000; FAO, 2011; Aguilar et al., 2015) that suggest that women's access to land is very limited, particularly in SSA.

In terms of the structural effects, the main contributors are marital status and farm size. However, the study attempts cautiousness in the interpretation of the determinants of the structural effects, since the coefficients cannot be interpreted causally (Quisumbing, 1996; Peterman et al., 2011). Therefore, the results can only be recommended as guides to farm-level policy and future studies.

5 Conclusion and policy recommendations

This study focused on farm productivity gap differentials between male and female rice farm managers, using data from the Osun and Ogun states in Nigeria. The study contributes to the literature on gender studies in SSA. Using the OB gender decomposition model, the results indicate a gender productivity gap of 0.29, suggesting that female plot managers are 29% less productive than their male counterparts. The endowment effects, which measures the proportion of gender productivity gaps attributable to differences in observable characteristics between men and women, account for about 15% of the gap, while the structural effect (the portion of the gender differential due to returns of the same characteristics) explain approximately 98% of the gap. This result concur with other studies in SSA that had used the same framework to compute productivity and wage inequalities between men and women. This recurrent pattern, therefore, suggests a certain structure of SSA where women are less productive than men. The results from the group-specific regression indicate that differences in the private rate of returns to factors such as age, marital status, number of years in formal education, and farming experience contribute significantly to productivity differentials between male and female.

In terms of the endowment effects, covariates such as marital status, education, farm size and access to market information are the most critical factors, explaining productivity differences if women had the same characteristics as men. The results from the structural effects portion of the detailed decomposition did not permit this study to provide any further explanation, since the coefficient could not be interpreted as causality. However, the variables contributing to productivity have some farm-level policy implications. Eliminating gender gaps in farm productivity would have produced tangible benefits if women were empowered to live up to their potential. Since agriculture remains the key determinant of Nigerian economic growth, paying attention to these productivity gaps and factors contributing to these gaps is crucial in formulating policy interventions oriented towards women empowerment.

Availability of data and materials

The data that support the findings of this study can be obtained from the authors upon request.

Ethics approval and consent to participate

The study received an ethical clearance and each participant signed a consent form

Conflict of interests

The authors declare that they have no competing interests.

Acknowledgement

We are very grateful to the enumerators and the farmers who seated patiently for hours providing responses to the questionnaire.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Addison, M., Ohene-Yankyera, K. & Fredua-Antoh, E. 2016. Gender role, input use and technical efficiency among rice farmers at Ahafo Ano North District in Ashanti Region of Ghana. *Journal of Food Security*, 4(2), 27–35.

Adeyeye, J.A., Navesero, E.P., Ariyo, O.J. & Adeyeye, S.A. 2010. Consumer preference for rice consumption in Nigeria. *Journal Human Spcial Sci. Crtv. Arts*, 5(1), 26-36.

Adimassu, Z., Kessler, A. & Stroosnijder, L. 2014. Farmers′ strategies to perceived trends of rainfall and crop productivity in the Central Rift Valley of Ethiopia. *Environmental Development*, 11, 123–140.

Agboola, S. A. (1979). An agricultural atlas of Nigeria. An agricultural atlas of Nigeria.

Aguilar, A., Carranza, E., Goldstein, M., Kilic, T. & Oseni, G. 2015. Decomposition of gender differentials in agricultural productivity in Ethiopia. *Agricultural Economics,* 46, 311–334.

Alene, A.D., Manyong, V.M., Omanya, G.O., Mignouna, H.D., Bokanga, M. & Odhiambo, G.D. 2008. Economic efficiency and supply response of women as farm managers: Comparative evidence from Western Kenya. *World Dev*. 36(7), 1247–1260.

Amaechina, E.C. & Eboh, E.C. 2017. Resource use efficiency in rice production in the lower Anambra irrigation project, Nigeria. *Journal of Development and Agricultural Economics,* 9(8), 234–242.

Ayinde, O.E., Adewumi, M.O. and Ojehomon, V.E. 2009. Determinants of Technical Efficiency and Varietal–Gap of Rice Production in Nigeria: A meta-Frontier Model Approach. A paper presented at the *International Association of Agricultural Economics conference*, 16–22 August 2009 Beijing, China.

Awotide, B.A., Karimov, A., Diagne, A. & Nakelse, T. 2013. The impact of seed vouchers on poverty reduction among smallholder rice farmers in Nigeria. *Agricultural Economics,* 44(6), 647–658.

Backiny-Yetna, P., & McGee, K. (2015). Gender differentials and agricultural productivity in Niger. The World Bank.

Backiny-Yetna, P. & McGee, K. 2015. Gender differentials and agricultural productivity in Niger. *Policy Research Working Paper*, No. 7199, The World Bank.

Bamidele, F.S., Abayomi, O.O. & Esther, O.A. 2010. Economic analysis of rice consumption patterns in Nigeria. *Journal of Agricultural Science and Technology*, 12(1), 1–11.

Barrett, C.B. 1996. On price risk and the inverse farm size productivity relationship. *J. Dev. Econ*. 51(2), 193–215.

Bechtold, K.B. & Abdulai, A. 2014. Combining attitudinal statements with choice experiments to analyze preference heterogeneity for functional dairy products. *Food Policy*, 47, 97–106.

Benjamin, D. 1995. Can unobserved land quality explain the inverse productivity relationship? *J. Dev. Econ.* 46(1), 51–84.

Blinder, A. 1973.Wage discrimination: reduced form and structural estimates. *J. Hum. Resour.* 8(4), 436–455.

Call, M., Gray, C. & Jagger, P. 2019. Smallholder responses to climate anomalies in rural Uganda. *World Development*, 115, 132–144.

Chirwa, E.W. 2005. Adoption of fertiliser and hybrid seeds by smallholder maize farmers in Southern Malawi. *Development Southern Africa,* 22(1), 1–12.

Cochran, W. G. (1977). Sampling techniques (3rd ed., 72-74)

Diiro, G.M., Seymour, G., Kassie, M., Muricho, G. & Muriithi, B.W. 2018. Women's empowerment in agriculture and agricultural productivity: Evidence from rural maize farmer households in western Kenya. *PloS one,* 13(5), e0197995.

Doss, C. R. (2018). Women and agricultural productivity: Reframing the Issues. Development Policy Review, 36(1), 35-50.

Dossah, B.O. & Mohammed, I.U. 2016. Evaluation of Gender Differences in Resource Utilization and Technical Efficiency of Irrigated Vegetable Farming in Plateau State, Nigeria. *European Journal of Basic and Applied Sciences*, 3(2).

Due, J.M., & Gladwin, C.H. 1991. Impacts of structural adjustment programs on African women farmers and female-headed households. *American Journal of Agricultural Economics*, 73(5), 1431–1439.

Eastwood, R., Lipton, M., Newell, A. 2010. Farm size. *Handbook Agr. Econ*. 4, 3323–3397.

Fafchamps, M. & Quisumbing, A.R. 2002. Control and ownership of assets within rural Ethiopian households. *J. Dev. Stud.,* 38(6), 47–82.

Fageria, N.K. & Baligar, V.C. 2003. Methodology for evaluation of lowland rice genotypes for nitrogen use efficiency. *Journal of Plant Nutrition,* 26(6), 1315–1333.

Fageria, N.K., Moreira, A. & Coelho, A.M. 2011. Yield and yield components of upland rice as influenced by nitrogen sources. *Journal of Plant Nutrition*, 34(3), 361–370.

Fisher, M. & Kandiwa, V. 2014. Can agricultural input subsidies reduce the gender gap in modern maize adoption? Evidence from Malawi. *Food Policy*, 45, 101–111.

Food and Agriculture Organization of the United Nations (FAO). 2011. The State of Food and Agriculture 2010–2011. *Women in Agriculture: Closing the Gender Gap for Development.* FAO, Rome.

Fortin, N., Lemieux, T. & Firpo, S. 2011. Decomposition methods in economics. In *Handbook of labor economics* (4, 1–102). Holland: Elsevier North.

GRiSP (Global Rice Science Partnership). (2013). Rice almanac.

Goldstein, M. & Udry, C. 2008. The profits of power: Land rights and agricultural investment in Ghana. *Journal of Political Economy*, 116(6), 981–1022.

Hammer, G.L., McLean, G., Chapman, S., Zheng, B., Doherty, A., Harrison, M.T. & Jordan, D. 2014. Crop design for specific adaptation in variable dryland production environments. *Crop and Pasture Science*, 65(7), 614–626.

Hitayezu, P., Okello, J.J. & Gor, C.O. 2010. Drivers of Household Participation in the Rural Non-Farm Labor Markets in the Post-War Rwanda (No. 320-2016-10088).

Iiyama, M., Kariuki, P., Kristjanson, P., Kaitibie, S. & Maitima, J. 2008. Livelihood diversification strategies, incomes and soil management strategies: a case study from Kerio Valley, Kenya. *Journal of International Development: The Journal of the Development Studies Association*, 20(3), 380–397.

Kadiri, F.A., Eze, C.C., Orebiyi, J.S., Lemchi, J.I., Ohajianya, D.O. & Nwaiwu, I.U. 2014. Technical efficiency in paddy rice production in Niger Delta Region of Nigeria. *Global Journal of Agricultural Research*, 2(2), 33–43.

Kilic, T., Palacios-Lopez, A. & Goldstein, M. 2013. Caught in a productivity trap: A distributional perspective on gender differences in Malawian agriculture. *Policy Research Working Paper,* No. 6381, The World Bank.

Kilic, T., Palacios-Lopez, A. & Goldstein, M. 2014. Caught in a productivity trap: A distributional perspective on gender differences in Malawian agriculture. Available from: http://dx.doi.org/10.1016/j.worlddev.2014.06.017.

Kilic, T., Palacios-Lopez, A., & Goldstein, M. (2015). Caught in a productivity trap: a distributional perspective on gender differences in Malawian agriculture. World Development, 70, 416-463.

Kinkingninhoun-Mêdagbé, F., Diagne, A., Simtowe, F., Abgoh-Noameshie, A. & Adegbola, P. 2010. Gender discrimination and its impact on income, productivity, and technical efficiency: Evidence from Benin. *Agr. and Hum. Values,* 27(1), 57–69.

Kurukulasuriya, P. & Mendelsohn, R. 2008. *How will climate change shift agro-ecological zones and impact African agriculture?*. The World Bank.

Mukasa, A,N. and Salami, A.O. 2015, Gender productivity differentials among smallholder farmers in Africa: A cross-country comparison. *Working Paper Series,* No. 231, African Development Bank, Abidjan, Côte d'Ivoire.

Mulwa, C., Marenya, P. & Kassie, M. 2017. Response to climate risks among smallholder farmers in Malawi: A multivariate probit assessment of the role of information, household demographics, and farm characteristics. *Climate Risk Management*, 16, 208–221.

Oaxaca, R. 1973. Male-female wage differentials in urban labor markets. *Int. Econ. Rev.* 14, 693–709.

Ogunlela, Y. I., & Mukhtar, A. A. (2009). Gender issues in agriculture and rural development in Nigeria: The role of women. Humanity & social sciences Journal, 4(1), 19-30.

Ojo, T.O., Baiyegunhi, L.J.S. & Salami, A.O. 2019. Impact of Credit Demand on the Productivity of Rice Farmers in South West Nigeria. *Journal of Economics and Behavioral Studies,* 11(1), 166–180.

Omondi, S.O. & Shikuku, K.M. 2013. An analysis of technical efficiency of rice farmers in Ahero Irrigation Scheme, Kenya. *Journal of Economics and Sustainable Development*, 4(10), 9–16.

Pender, J. & Fafchamps, M. 2000. Land lease markets and agricultural efficiency: Theory and evidence from Ethiopia. *CSAE Working Paper,* No. 2002–19.

Peterman, A., Quisumbing, A.R., Behrman, J. & Nkonya, E. 2011. Understanding the complexities surrounding gender differences in agricultural productivity in Nigeria and Uganda. *J. Dev. Stud*.. 47(10), 1482–1509.

Peterman, A., Behrman, J. A., & Quisumbing, A. R. (2014). A review of empirical evidence on gender differences in nonland agricultural inputs, technology, and services in developing countries. In Gender in agriculture (pp. 145-186). Springer, Dordrecht.

Quisumbing, A. R. (1995). Gender differences in agricultural productivity: a survey of empirical evidence (No. 583-2016-39541).

Quisumbing, A.R. 1996. Male-female differences in agricultural productivity: Methodological issues and empirical evidence. *World Dev.,* 24(10), 1579–1595.

Quisumbing, A. R., & Pandolfelli, L. (2010). Promising approaches to address the needs of poor female farmers: Resources, constraints, and interventions. World development, 38(4), 581-592.

Ragasa, C. (2012). Gender and institutional dimensions of agricultural technology adoption: a review of literature and synthesis of 35 case studies (No. 1007-2016-79530).

Saito, K.A., Mekonnen, H. & Spurling, D. 1994. Raising the productivity of women farmers in sub-Saharan Africa. *Africa Technical Department Paper Series 230. The World Bank.*

Shah, A. & Kulkarni, S. 2008. Gender Dimensions of Water Governance and Management, Session Title: Interface between Water, Poverty and Gender Empowerment: Revisiting Theories, Policies and Practices. Draft paper for International conference organized by Sactwaters. Available from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.549.9585&rep=rep1&type=pdf.

Smale, M. 2011. Does household headship affect demand for hybrid maize seed in Kenya? An exploratory analysis based on 2010 survey data (No. 1096-2016-88421).

Tesfahunegn, G. B., Mekonen, K., & Tekle, A. (2016). Farmers' perception on causes, indicators and determinants of climate change in northern Ethiopia: Implication for developing adaptation strategies. Applied Geography, 73, 1-12.

Tiruneh, A., Tesfaye, T., Mwangi, W. & Verkuijl H. 2001. Gender differentials in agricultural production and decision-making among smallholders in Ada, Lume, and Gimbichu Woredas of the Central Highlands of Ethiopia. Ethiopian Agricultural Research Organization (EARO) and International Maize and Wheat Improvement Center (CIMMYT), Mexico, D.F.

Vargas Hill, R. & Vigneri, M. 2014. Mainstreaming gender sensitivity in cash crop market supply chains. In: Quisumbing, A.R., Meinzen-Dick, R., Raney, T.L., Croppenstedt, A., Behrman, J.A. & Peterman, A. (Eds). Gender in Agriculture. Springer, Netherlands.

World Bank (2011). World development report 2012: Gender equality and development. Washington DC: World Bank.