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Institutional Factors and Gender Role in Rural Technology Adoption in Nigeria

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Abstract. Rural development agenda could be affected by institutional issues and gender differences in access to rural based technology. This study examines the influence of institutional factors from gender perspective, on rural technology adoption decision of rural households in Nigeria. Primary data were collected for the study using structured questionnaire. The data collected from randomly sampled respondents were fitted to Heckman selection model. Results show that access to credit and new seed technology exerts significant influence on adoption decisions of male and female rural households. While institutional factor of access to credit affects both male and female, access to the technology is more favourable to male. The findings suggest the need for inclusive support, through institutional intervention, for both rural male and female households to achieve rural developmental objectives.

Keywords: rural development, gender, credit access, adoption, heckman.

1. Introduction

Among several challenges facing most developing economies, rural development is foremost due to peculiarities of rural inhabitants, shortage of infrastructural facilities, low income earnings and limited availability of productivity enhancing technology in most rural communities (Epstein & Jeseph, 2001). Existence of suitable technology in the rural sector is capable of boosting food production and enhancing livelihood strategies of most peasants, who constitute the largest population in various rural communities (Hesselberg & Yaro, 2006). Part of the importance of ensuring availability of appropriate rural technology is potential for reducing rural-urban migration, unemployment and poor earnings (Lanjouw & Lanjouw, 2001). Nonetheless, involving rural people in development related programmes is important to deliver the necessary technological needs of the rural people.

Technological needs of the rural people vary and depend largely on socio-economic conditions of the people residing in the rural areas (Sofoluwe, Tijani & Kareem, 2013). In a largely agrarian rural set-up, farming related technologies such as improved seed varieties, fertilizer and machinery would be more appropriate. With special consideration for overall populace of the rural people and infrastructural needs, communication technology, efficient transport system with good road networks could be of importance. However, one of the vital expectations from the rural areas is provision of food for the teeming population of a country. Consequently, the most required technology in the sector, should be food related and this would include provision of new seed varieties and related innovations.
Evidence from the developing world indicated that men and women do not use new technologies at the same rate or do not benefit equally from them. Understanding gender differences in use of such technologies may help agricultural research systems develop new varieties and technologies, aid extension systems in identifying the most binding constraints to their use, and help development practitioners and policymakers address the gender specific constraints (Meinzen-Dick et al., 2010). It will also suggest some criteria for evaluating the gender-specific impact of new technologies, which may help guide the prioritization of technologies to be developed and the choice of technology to disseminate in particular settings.

Gender differences in agricultural sector arising from socio – economic, cultural and institutional factors impose real costs on society in terms of untapped potential in increasing agricultural productivity,

financial and productive assets acquisition of farmers. Therefore, strategies and approaches promoting gender equality in productivity enhancing technology and access to productive resources and economic opportunities should be devised and adopted. This will not only lead to the empowerment of rural farmers irrespective of gender, but also important for agricultural and increasing food supply for overall economic development (Meinzen-Dick *et al*., 2010).

Provision and availability of technological innovations are not as important as adoption of such innovations by the expected populace. Hence, understanding the possible determining factors driving acceptance of innovations in the rural sector would remain of significant interests to academics, researchers, practitioners, government agencies and international donors. Studies have indeed examined the drivers of technological innovations in rural areas. But, some of the identified factors have not been adequately classified. On a broad scale, institutional factors include access to credit, land ownership and acquisition in addition to government and non-governmental influence in the life of the rural people (Sofoluwe, 2015).

In spite of numerous studies carried out to examine adoption of innovations in developing countries like Nigeria, to the best of our knowledge, there is limited focus on institutional factors affecting adoptions of innovations in rural sector of Nigeria. Hence, the aim of the study is to determine and examine the institutional factors driving adoption of seed technology innovations in addition to individual characteristics of rural dwellers along gender line, and proffers possible strategies for enhancing acceptance of development related innovations in developing countries using Nigeria experience.

The rest of the papers are organized in sections. Review of relevant literature with reference to adoption of technologies and innovations is next, followed by methodology of the study, results and discussions. The last section concludes the paper.

2. Literature Review

The work of Rogers (1962) on innovation remains a premise for understanding adoption related studies. An important outcome of Roger's study is that technology adoption could be measured in binary form; whether an individual adopts or not and that individual factors are relevant to providing clear understanding of technology adoption process. Subsequent studies have utilized this approach to explain adoption behaviour of individuals with respect to technology adoption (Sunding & Zilberman, 2001; Rogers, 2003). However, in rural settings of most developing nations like Nigeria, a lot of deficiencies in basic infrastructural needs could make individual factors less productive. The control exerted by institutions on rural governance could affect reactions and behaviour of rural dwellers to new technological innovations (Sofoluwe, 2015).

In the analysis of institutional and individual factors affecting adoption in Zimbabwe, Mazvimavi & Twomlow (2009) found that institutional support from government and non-governmental agencies are critical to adoption decisions of individuals. Meanwhile, they do not find any significant effect of individual factors on adoption. The findings of Ghimire, Wen-chi & Shrestha (2015) showed that individual characteristic such as education significantly explains adoption while institutional factors such as access to seed varieties and extension services also paly significant role in explaining adoption of technologies. In an effort to understand the factors driving adoption, Duvel *et al*. (2003) identified number of individual characteristics of gender, experience, education and capacity affect adoption of innovations. They also identified institutional factors of access to extension and credit. Weir and Knight (2004) also found that individual characteristics of education have significant influence on adoption of technological innovations. Similarly, Masangona & Miles (2004) found individual characteristics of education and gender to have significant influence on adoption of technologies. The finding puts an exception to institutional characteristics of respondents. Earlier study of Lemchi *et al*. (2005) in Nigeria showed that plantain technology adoption is directly influenced by social status, primary occupation and market factors.

Matuschke & Qaim (2006) in the analysis of adoption of hybrid wheat found that either farm size or primary occupation status have significant effect on adoption decision. Therefore, recommendation was made on the need to look at access to credit. Other findings from Zarale *et al*. (2006) included prices of new seed technology as part of the factors affecting adoption. Suggestions were also made with respect to analysing institutional related factors of access to credit, extension services and provision of rural infrastructure to understand adoption patterns of technology. Bertuglia & Calatrava-Requena (2006) studied adoption of plastic technology in horticulture farming business. They observed that education plays limited role in adoption but suggest that increase in farm size is significantly related to adoption of technological practices.

The finding of Bakshoodeh & Shajari (2006) on adoption of new seed variety by rice farmers showed that adoption decision is more associated with risk than other factors. The factor of risk is likely to increase probability of adoption alongside cost of production. Farm specific factors were also found to have negative effect on the decisions to adopt new seed varieties. Adekoye (2007) in the analysis of adoption of technologies found that variation in awareness about new technologies could be attributed to variations in adoption decision. Also Okuro *et al.* (2007) analysed the factors affecting adoption of maize seed technologies. Findings showed that gender, labour availability and extension services are important drivers of adoption. In Nigeria, adoption decisions have been conceptualized largely on socio-economic factors of adopting individuals, households and communities. This is largely due to poor poverty condition of the masses (Fashola *et al*., 2007).

However, most of the problems that influence behaviours and decisions could actually be institutional based since most people are directly or indirectly under institutional regulations. The literature suggests that a wide range of individual, farm specific and institutional factors influence gender differences in technology usage decisions. Proxies for individual characteristics such as age, education, and farming experience; proxies for farm characteristics such as farm size; proxies for institutional factors such as tenure status, access to credit and access to maize seed were included in the analysis to identify key determinants of gender differences in the use of improved maize variety.

The review of extant literature shows that most studies are largely interested in the specific nature of the technology being disseminated rather than the regulatory related factors. The consequence as observed is existence of inconclusive and recurring factors of adoption in most studies. This study takes a gap from these and focuses more on institutional factors that could drive technological adoption in rural communities.

3. Methodology

The study covers south-western geopolitical zone of Nigeria. The Southwestern zone lies between latitude 4˚N and 9˚N and longitude 3˚E and 6.2˚E. The climate of Southwest Nigeria is tropical in nature and it is characterized by wet and dry seasons. The temperature ranges between 21^{o} C and 34^{o} C while the annual rainfall ranges between 1500mm and 3000mm. The wet season is associated with the Southwest monsoon wind from the Atlantic Ocean while the dry season is associated with the northeast trade win from the Sahara desert. The study used random sampling techniques to select 1560 respondents from rural communities in the study area. Primary data were collected using questionnaire and covers information on individual characteristics of respondents and institutional factors of access to credit, land ownership and acquisition. Data collected were analysed using Heckman selection model which was implemented through maximum likelihood approach.

The general Heckman selection model can then be implicitly stated as:

$$Y_{1i} = X_{1i}\beta_1 + \mu_{1i}$$

$$Y_i = \begin{cases} Y_{1i} & iff\ Y_{1i}^{*} > 0 \\ no\ observation & iff\ Y_{1i}^{*} \leq 0 \end{cases}$$

The dependent variable Y, is measured as proportion of land allocated to new seed technology variety. The independent variables are stated as follows:

Age (Measured in years), age squared (quadratic measure of age variable measured in years), access to credit (Dummy: 1 if yes; 0 otherwise), experience (measured in years), Farm size (Measured in hectares), access to seed (Dummy: 1 if yes; 0 otherwise), membership of Association (Dummy: 1 if yes; 0 otherwise), Productive asset (Naira value), Education (Measured in years).

4. Results and Discussion

Socio Economic Characteristics of Respondents

Socio economic characteristics of respondents vary (Table 1). Age of male farmers using improved maize variety differs significantly ($t = 1.79$, $p > 0.10$) from the female farmers. Whereas the average age of male farmers was found to be 52 years; that of female farmers using improved maize variety was approximately 50 years. The lowest age bracket of both male and female was between 20 and 30 years with approximated percentage of 5 and 1 respectively. However, the highest age bracket of male farmers is greater than 70 years with a very low percentage

(3%). Female farmers using improved maize variety were within the highest age bracket of 61 to 70 years with an estimated percentage of 19 approximately. Overall, most (40%) of male farmers were within the age range of 51 to 60 years. On the contrary, most (48.2%) of the female farmers of improved maize variety are in the age range of 41 to 50 years. Results across groups showed that the highest percentage (38.8%) of sampled improved maize variety farmers were within the age range of 41 and 50 years. The estimated average for all respondents was found to be 51 years.

Table 1: Socio-Economic Characteristics of Respondents

Variables	Male	Female	Pooled	Mean difference
	Frequency (%)			
Age				
20-30	9(4.5)	2(1.4)	11(3.3)	
31-40	16(8)	17(11.7)	33(9.6)	
41-50	63(31.9)	71(48.2)	134(38.8)	1.79*
51-60	79(40)	45(30.7)	124(36)	
61-70	24(12.1)	13(18.9)	37(10.8)	
> 70	6(3)	0(0)	6(1.8)	
Mean	52.11	49.82	51.13	
Standard deviation	9.80	8.19	9.2	
Farm size				
< 1	41(20.7)	56(38.0)	97(28.3)	
1-2.5	137(69.5)	78(52.7)	215(62.3)	
3-3.5	16(8.1)	13(9.5)	30(8.7)	
4- 4.5	1(0.5)	0(0)	1(0.3)	3.69***
≥ 5	2(1.0)	0(0)	2(0.6)	
Mean	1.68	1.29	1.52	
Standard deviation	0.84	0.83	0.86	
Farming experience				
1-5	4(2)	8(5.4)	12(2.5)	
6-10	47(23.9)	36(24.32)	83(24.1)	1.75*
> 10	146(74.1)	104(70.27)	250(73.4)	
Mean	19.38	17.82	18.71	
Standard deviation	10.31	9.82	10.12	
Years of education				
0-6	91(46.1)	106(71.6)	197(57.1)	
7-12	61(30.9)	22(14.9)	83(24.1)	4.11***
> 12	45(23)	20(13.6)	65(18.8)	
Mean	8.16	5.30	6.93	
Standard deviation	5.58	1.43	5.69	
Mode of land acquisition				
Rent	38(20.7)	22(16)	60(18.7)	
Inherited	86(47)	70(51.1)	156(48.8)	
Purchased	24(13.1)	21(15.3)	45(14.1)	-0.73
Leased	27(14.8)	16(11.7)	43(13.4)	
Gift	8(4.4)	8(5.8)	16(5.0)	

*, ***, significant at 10% and 5% respectively

Average farm size of male farmers was found to be significantly higher than that of female farmers ($t = 3.69$, $p < 0.05$). Average farm size of male farmers was 1.7 hectares while that of the female farmers stood at an average of 1.3 hectares. This indicates a significant gender differences in area of land cultivated by male and female farmers of improved maize variety. Further descriptive statistics showed that majority of respondents among male (69.5%) and female (52.7%) farmers using improved maize variety cultivated between 1 and 2.5 hectares of land for improved maize variety respectively. About 21 per cent of the respondents among male farmers cultivated less than 1 (one) hectare of land for improved variety whereas 38 per cent of female farmers using improved maize variety cultivated similar size of farm land. The higher percentage of female farmers with lower farm size, relative to the male farmers underscores gender differences in access to productive assets acquisition. Furthermore, gender distribution of respondents according to farm size showed that none of the female farmers cultivated above 3.5 hectares of farm land for improved maize variety. Across gender groups, the average farm size was found to be approximately 1.52 hectares.

Accumulated years of experience in maize farming also differs significantly ($t = 1.75$, $p < 0.10$) between male and female farmers using improved maize variety. Average years of experience were estimated to be 19 and 18 years respectively for male and female farmers. However, more (5.4%) female farmers were found to have acquired farming experience of between 1 and 5 years relative to 2 per cent statistical value obtained for male farmers using improved maize variety. Also, approximately 24 per cent of both male and female farmers have acquired farming experience ranging between 6 and 10 years. But higher percentage (74%) of male farmers was found to have accumulated years of farming

experience above 10 years relative to percentage (70%) of female farmers who acquired similar years of farming experience. For all the sampled respondents, the average years of farming experience was approximately 19 years.

Furthermore, descriptive statistics showed gender differences in years of education of male and female farmers using improved maize variety. Average years of education (8 years) of male farmers was found to be significantly different ($t = 4.11$, $p < 0.05$) from average years of education of female farmers (5 years). Most (46 %) of the male farmers had between 0 and 6 years of education whereas it was majority of female farmers (72%) that had similar range of years of education. Years of education of about 31 per cent of male farmers were within 7 to 12 years while it was approximately 15 per cent for female farmers of improved maize variety. More male farmers (23%) had over 12 years of education relative to about 14 per cent of female farmers who had similar years of education. However, average years of education for all the respondents were approximately seven (7) years.

Most of male (47%) and female (51%) farmers using improved maize variety acquired land for farming through inheritance. However, the percentage of male farmers (21%) who acquired land through rent was higher relative to female farmers' (16%). But more female farmers (15%) purchased the land compared to male farmers (13%) using improved maize variety. About 15 per cent of male farmers were able to acquired land through leasing while about 12 per cent of female farmers acquired the land through same source.

Factors influencing gender differentials in adoption

Maximum likelihood estimates of Heckit model of factors influencing gender differentials in the use of IMV are presented in Table 2. In the estimated model, β is a vector of Heckit Maximum Likelihood estimates. The Lambda is significant indicating the goodness of fit and its consistency compared to the use of least square approach. The null hypothesis in the maximum likelihood estimates is that the independent variables are not significantly different from zero in assessing the expected value of the decision to use improve maize variety by male and female farmers. This null hypothesis was rejected, implying a significant difference from zero for the independent variables. Some of the coefficients were significantly different from zero at the 0.10, 0.01, and 0.05 levels of significance.

From the MLE estimates, the individual factors influencing gender differentials in the use of improved maize variety are age and productive assets. Institutional factors such as access to credit and seeds were the significant factors influencing gender differentials in the use of improved maize variety. But, only access to credit is positive and significant for both farmers; access to seed does not significantly influenced decision of female farmers. The farm specific factors that significantly ($p < 0.05$) influenced gender differences in the use of improved maize variety are farm size and location characteristics.

Specifically, the results revealed that the coefficients of individual factor such as age and its quadratic form (age square) were statistically significant ($p < 0.10$) and positive to male and female farmers decision. The positive coefficient associated with age of both male ($\beta = 0.07$, $p < 0.10$) and female ($\beta = 0.05$, $p < 0.10$) farmers using improved maize variety indicated that older farmers among male and female are more likely to use improved maize variety (Mazvimavi, 2004).

Table 2: Maximum Likelihood Estimates of Heckit Model

	Maximum Likelihood Estimate	
Variable	Male	Female
Age	0.07* (1.81)	0.05***(4.92)
Age square	0.01*(1.88)	0.04**(4.92)
Access to credit	0.030**(2.49)	0.062**(2.80)
Experience	-0.001(-0.88)	-0.002(-1.26)
Farm size	0.114***(4.73)	0.121**(2.97)
Access to seed	0.03*(1.89)	0.02(1.23)
Membership	0.013(0.65)	0.017(0.79)
Asset	0.010**(2.79)	0.04***(3.29)
Education	-0.001(-0.92)	0.01(0.62)
O_y-D	0.014**(2.16)	0.05**(2.43)
O_s-D	0.121(1.57)	0.04(1.62)
O_g-D	0.022(0.99)	0.46**(1.98)
Constant	0.031**(2.38)	1.11**(4.68)
Lambda	-0.09**(-2.06)	-0.11***(-2.43)

***, **,*, significant at 1%, 5% and 10% respectively

Values in bracket are z values

The influence of changing life cycle of male and female farmers was captured with addition of quadratic function to the age and the ML estimates showed a negative and significant influence of changing life cycle on decision of male ($\beta = -0.01$, $p < 0.10$) and female ($\beta = -0.04$, $p < 0.05$) farmers to use IMV. As farmers grow older, they become more skilful, through learning by doing. But this trend attenuates as they reach middle age and their physical strength begins to decline. Consequently, very aged farmers become more risk averse and less willing to adopt new farming technologies (Mazvimavi and Twomlow, 2009). The influence of changing life cycle on female farmers using improved maize variety is significantly higher ($p < 0.05$) than its influence on male ($p < 0.10$).

Parameter estimates of institutional factor such as access to credit was significant and positive to decision of both male ($\beta = 0.03$, $p < 0.05$) and female farmers ($\beta = 0.06$, $p < 0.05$) to use IMV. The positive sign associated with access to credit indicates the importance of access to institutional services such as credit to decisions of male and female farmers to use IMV. In line with Doss (2001) and Tiwari (2010) credit is needed to finance a new agricultural technology. Credit may be tied to purchase of IMV, hence access to credit may be crucial to using IMV. Institutional support in the form of access to credit can build the confidence of male and female maize farmers leading to increase in their investment on farm activities despite uncertainty, as this can help individual farmers smooth consumption and maintain productive capacity by reducing the need to liquidate the acquired assets.

Results further showed that parameter estimate of another institutional factor- access to seed is only significant and positive to decision of male farmers ($\beta = 0.03$, $p < 0.10$) rather than the female farmers ($\beta = 0.02$, $p > 0.05$), to use improved maize variety. This implies that access to productive resources such as improved seed variety is crucial to balancing gender differentials in the use of improved seed variety. The positive sign and significance of the variable 'access to seed' implies that the provision (public or private) of maize seed variety in the right quantity, form, and time has been more favourable to male farmers in the study area. This finding affirms assertion in theoretical literature such as Tiwari (2010) and Holden and Bezabih (2007) that one of the sources of gender differences is limitation of female farmers in accessing productive agricultural resources.

Parameter estimates of total farm size (farm specific factor) was significant ($p < 0.05$) and positive to decision of both male and female farmers to use IMV. The positive coefficients of farm size showed that the use of improved maize variety by male ($\beta = 0.114$, $p < 0.05$) and female ($\beta = 0.121$, $p < 0.05$) maize farmers increases as available land for cultivation increases. The significance of the variables lies in the necessity of increase in farm size to agricultural intensification and its attendant effect on productivity. The influence of farm size suggests that male or female farmers who hold large farms are more likely to invest in improved maize variety. This finding is line with the argument that larger farm owners have more flexibility in their decision making, greater access to discretionary resources, and more opportunity to use new practices on a trial basis with more ability to deal with the associated risk

Location characteristics captured by location dummy was found to have significant influence on gender differences in the use of IMV. Parameter estimates of Oyo state dummy showed that the use of IMV by both male and female farmers is significantly ($p < 0.05$) by differences in farm location. More specifically, female farmers using IMV in Ogun state are more significantly ($p < 0.05$) influenced by farm location characteristics than male. The results indicate the need to assess gender issue in IMV wholistically; incorporating the view of all other agricultural scientists (soil and crop scientists) alongside agricultural economists in managing gender differences in the use of IMV.

The coefficient of productive asset has a positive and significant influence on decision of male ($\beta = 0.01$, $p < 0.05$) and female ($\beta = 0.004$, $p < 0.05$) farmers to use IMV. The results showed that increasing the productive assets of male and female maize farmers such as implements and means of transportation for maize farming activities can increase the likelihood of use of improved maize variety. Existing studies such as Nkonya *et al*. (2012) have shown the importance of assets acquisition in increasing the cropping areas under improved agricultural intervention. Asset acquisition represents alternative source of credit to male and female farmers which could help the farmers in solving liquidity problems. Further, asset enables different livelihoods, with a greater stock and diversity of assets being associated with more diverse livelihoods and better well-being outcomes.

5. Conclusions

Individual factors that influenced gender differentials in the use of IMV were individual factors of age and changing life cycle of male and female farmers using

improved maize variety. Institutional factors influencing gender differences in the use were access to resources such as credit and seed. Whereas both male and female farmers are significantly influenced by institutional factor of access to credit, male farmers are additionally influenced by access to seed. Farm size and location characteristics are the farm specific factors that significantly influence gender differences in the use of improved maize variety. The strength of the influence of the individual, institutional and farm specific factors however, differs across gender.

The findings of this study also lead to the conclusion that gender differentials in the use of improved maize variety are shaped by a host of individual, institutional and farm specific factors. More importantly, changing life cycle, access to credit and farm size are crucial factors to understanding causes of gender differentials in the use of improved maize variety. In order to address differences in the use of improved maize variety by male and female farmers, attention of agricultural research officers, extension agents, policy makers and social analysts should be focused on farmer, farm and institutional segments based on characteristics such as age, farm size, location characteristics and access to credit.

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