Scientific Papers Series Management , Economic Engineering in Agriculture and Rural Development
Vol. 13, Issue 2, 2013
PRINT ISSN 2284-7995, E-ISSN 2285-3952

WHAT DRIVES TECHNOLOGY UTILISATION, LEARNING AND TRANSFER IN AGRICULTURE? LESSONS FROM NIGERIAN WOMEN FARMERS

Olajumoke ADEYEYE[1], Oluwatosin Gbemisola OLADIPO[2], Adedamola David ADEYEYE[2]

[1]LaRen Consulting, LR Suite, Oduduwa Hall, PMB 039, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria; Phone: +2347069060451, Email: jummi24@yahoo.co.uk
[2]National Centre for Technology Management, Federal Ministry of Science and Technology, PMB 012, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria; Phone: +2348133786091, Email: thosyney2k1@yahoo.co.uk
[2]National Centre for Technology Management, Federal Ministry of Science and Technology, PMB 012, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria; Phone: +234834406502, Email: david.adeyeye@nacetem.org

Corresponding author: jummi24@yahoo.co.uk

Abstract

This study examines the factors that drive technology utilisation, learning and transfer among women farmers in Nigeria. It assesses both modern and indigenous technologies used in farming activities. Three states were purposively selected from the six that comprise the South West geopolitical zone of the country. Structured questionnaire was administered to 180 women smallholder farmers who were randomly selected in equal proportion across the three states. Some 128 copies of questionnaire were retrieved representing a response rate of about 71%. The study reveals that majority of the women (about 67%) use indigenous technologies while only a few (17%) and 16% use modern technologies and a combination of both respectively. Family and friends are the main source of learning indigenous technologies while extension agents are the major source of modern. The study uses spearman correlation to determine the drivers of the dependent variables. Age, level of education, years of experience and learning intensity are significantly correlated with technology utilisation at 1% level of confidence while primary occupation and learning have significant correlation with technology learning at 5% and 1% confidence level respectively. The study also reveals that farmers' age, experience and availability of learning system are have significant correlation with technology transfer. The study advocates the introduction of need and gender-specific new technologies. There is the need for integration of indigenous technologies into research so that it can be attractive to the older women. Also, farmers should be integrated into the technology development process. This will help in sustaining the rising interest of younger women in adapting modern and indigenous technologies in agriculture. The study also advocates the need for deeper and broader interactions among key actors, such as, R&D institutions, extension agents, NGOs, CBOs and farmers on the effectiveness and variety of channels used in technology learning, utilisation and transfer. Appropriate public policy interventions should also be introduced to develop 'smallholder-friendly' technologies, especially among women, to curb market failures in technology adoption.

Key words**:** *learning, Nigeria, technology utilisation, technology transfer, women farmers*

INTRODUCTION

In Nigeria, agriculture has a huge potential of being the key driver of economic growth and development. However, productivity in the sector has remained low despite large deposits of natural resources and increased R&D investments. The vast arable land mass of 79 million hectares and conducive soil and weather conditions in most areas of the country support virtually all forms of agricultural production. In 2007, approximately 70 percent of the national labour force was employed in agriculture, up from 54 percent in 1980 (NPC, 2009). In 2011, agriculture contributed the highest proportion of 40% to Nigeria's Gross Domestic Product (GDP). Prior to mid 1990s, investment in agricultural R&D was not too encouraging. However, starting from the mid

1990s, R&D investments assumed a new dimension with a gradual rise in expenditure. Recent statistics shows that Nigeria spent about 24 billion Naira (392 million USD) on agricultural R&D in 2008. This is four times higher than the 1995 spending level, and twice as much as those of the late-1970s and early 1980s (Flaherty *etal.,* 2010). The liberalisation of the university system in 1999 has also led to a quantum leap in the number of universities from 36 in 1999 to 124 in 2012, an increase of about 350%. Out of this, 3 are dedicated agriculture universities while virtually all the remaining has departments or faculties of agriculture. Also, Nigeria has about 70 research institutes with 15 in the Ministry of Agriculture. The 2007 Nigerian R&D survey shows that agriculture and food security accounted for the highest sub-sectoral R&D spending with about 20% (NACETEM, 2012). More than one-third of the growth in agricultural spending in sub-Saharan Africa is attributed to an increase in R&D spending in Nigeria. The country also accounted for the rise in regional growth in the number of researchers. It accounted for about 32% in the African regional FTE growth between 2001 and 2008 (Beintema and Stads, 2011).

Despite all these, there is rising food insecurity in Nigeria. Unemployment rate has doubled from 12% in 2006 (NBS, 2011) to 24% in 2011 (NBS, 2012). Relative poverty level has also risen from 54% in 2004 to 69% in 2010 (Onuba, 2012). One of the key reasons for these is the failure to successfully commercialise R&D outcomes as well as failure in the adoption process for the few commercialised ones especially among smallholder farmers (Lipton, 1988). A recent study in Papua New Guinea found out that low adoption of modern farming practices by smallholder farmers is the core problem in both the cocoa and coconut industries (Komolong *etal.,* 2012). In India, about 60% of the farmers, mostly smallholders, had not accessed any source of modern technology (Birner and Anderson, 2007). Smallholder agriculture, which is the predominant source of livelihoods in Nigeria, has proven to be at least as efficient as larger farms when farmers have received similar support services and inputs. However, there is a rising belief in policy circle that for hunger, poverty and inequality to be reduced, smallholder farmers must be at the epicenter for agriculture and innovation policy development and implementation. IFPRI's global food model projections to 2015 show that a smallholder-led agricultural transformation of Africa is feasible both technically and economically. A 1-percent increase in yields can help 6 million more people raise their incomes above US$1 per day. Smallholder-led growth strategy focusing on efficiency in food production systems through the utilisation of technological innovations could lead to huge cuts in Africa's rural poverty within a couple of decades (IFPRI, 2002).

Women constitute about 43% of agricultural labour force in developing countries, (ActionAid, 2011) and between 60 to 80% in Nigeria (World Bank, 2003 as cited in Ogunlela and Mukhtar, 2009). Issues pertaining to women need to be taken into consideration during technology development and transfer process to increase the chances of adoption (Okoye *etal.,* 2008). They have been proven to be less opened to adopting new technologies than men despite playing a major role in agriculture process (Doss, 2001). Researchers and policymakers rarely take into account gender-specific opportunities and constraints in access to technology and techniques for improving agricultural production (Odebode, 2002). The main factors that influence the adoption, utilisation and transfer of technologies among smallholder farmers is of great importance for policy, especially within a developing country like Nigeria where little attention is paid to 'smallholder-friendly' technology issues. Factors that determine these have not been dully accessed in Nigeria. The study specifically examined the utilisation of indigenous and modern technologies by women smallholder farmers. It also assesses the sources, modes and factors influencing the transfer, utilisation and learning of the technologies.

The rest of the study is structured as follows. Section 2 presents a brief review of the

research and development in agricultural sector in Nigeria. This is followed in Section 3 by a review of the extant literature on technology learning capability and transfer. The section highlights, from the literature, the key determinants of technology learning, utilisation and transfer among farmers. In Section 4, the method and theoretical framework employed by the study is detailed. The results are presented and discussed in Section 5 while Section 6 discusses the implications for policy and conclusion.

Technology learning and capability transfer

Recent studies advocated the need to replace linear models for knowledge transfer with interactive models (Adesina and Baidu-Forson, 1995; Saka *etal*., 2005; IFAD, 2012). The definition of technology transfer varies depending on the context (Bozeman, 2000). However, the underlining factor is the movement of technology from one entity to another (Sounder *etal.*, 1990). The process is deemed successful, if the receiver can effectively adapt, utilise and assimilate the new technology (Ramanathan, 1994). Madukwe *etal.*, (2002) described agricultural technology transfer as a mechanism of using appropriate methods to reach small scale farmers with relevant agricultural technologies in order to improve their knowledge, skill and overall attitude towards agricultural productivity. Central to the process of transfer is learning. Oyelaran-Oyeyinka (2002) described technology learning as the way in which firms acquire and build up technical knowledge and competencies. According to Figueiredo (2002), the learning processes used by companies in generating new knowledge and technologies are driven by multiple learning processes (variety), repeatability of learning processes (intensity), the way learning processes work over time (functioning) and how learning processes influence each other (interaction) (Figure 1). In agriculture, these four learning processes aid the process of technology transfer and sourcing among farmers.

For example, the variety of learning sources available to a farmer may determine the level of adoption and utilisation of such technologies (Bozeman, 2002). A farmer who learns through oral instruction in addition to farm demonstration by extension agents will more likely adopt the technology.

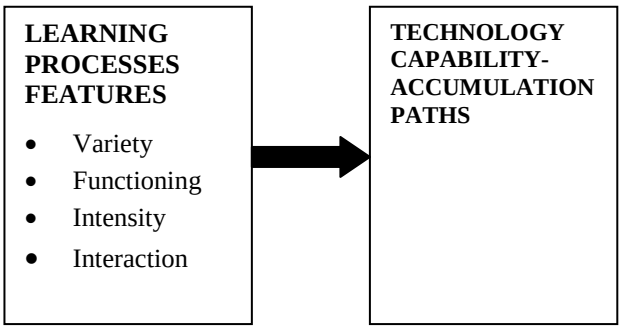

Fig.1.Technology Capability Leaning Processes
Source: Figueiredo, 2002

The repeatability of a mode of learning over time tends to strengthen the ability to adopt, utilise and master the technologies while transforming the farmer from user to source of technologies. Ultimately, the adoption or successful use of the technologies depends on the level of engagement of the farmers in the process of learning and transfer (Doss, 2001).

MATERIALS AND METHODS

a)Research Design and Sampling

The southwest region of Nigeria is one of the six geo-political zones in the country. The region comprises of six states: Ekiti, Lagos, Ogun, Ondo, Osun and Oyo. It is bounded by Kwara State in the north and Kogi and Edo States in the east, Republic of Benin in the west and Atlantic Ocean in the south. The southwest zone lies within latitude 7^{o} 01' and 8^{o} 14'.

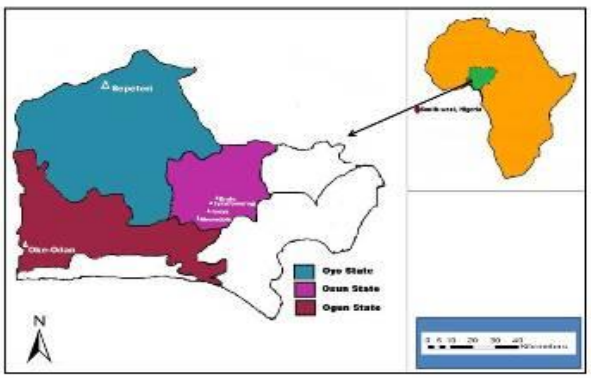

Fig. 2. Map of South West Nigeria (Study Area) and an insert map of Africa, showing Nigeria

The major tribes in this zone are the Yoruba and they are primarily sedentary farmers and traders. Figure 2 shows the map of the study area.

This study collected primary data through structured questionnaire administered to the respondents. A multistage sampling technique was used in selecting the respondents. First, three states (Oyo, Ogun and Osun) were purposively selected. These states form part of the Ogun-Osun River Basin Development Authority (RBDA), one of the eleven RBDAs established to develop and manage water resources in Nigeria. The high concentration of smallholder farmers around the River Basin necessitated the selection of the states and the sample sites. Some 180 women smallholder farmers were randomly selected in equal proportion from Sepeteri, Saki East Local Government (LG) (Oyo State); Oke Odan, Yewa North LG (Ogun State); Iyanfoworogi and Erefe, Ife East LG and Isoya and Akeredolu Ife South LG (Osun State). The study covers all aspects of agricultural practices such as horticulture, food and cash crop, livestock production and crop processing. Some 128 copies of questionnaire were retrieved representing a response rate of about 71%. The data were analyzed using descriptive and inferential statistics and organized in tables for presentation.

b)Variables and Measures

Table 1 gives a brief description of variables used in the statistical analysis.

The three dependent variables are determined from specific questions in the questionnaires. A total of seven independent variables are also included in the correlation analysis (Table 1).

c)Conceptual Framework

The 'transfer of technology' (TOT) model was widely accepted as the preferred model in the agricultural system. It is a rigid, linear, one-way process which regards the farmers as mere users of new technologies while the knowledge institutions are credited with the ingenuity of developing new technologies.

The farmers are considered as passive actors who lack the capability to influence the process of development of technologies (Roling, 1990). The model therefore fails in adapting research outcomes to local conditions leading to low adoption rate, especially among smallholders. Other models, however, have been developed to address this by highlighting the active roles played by users in the technology transfer and diffusion process (Ramanathan, n.d.; Biggs 1990).

Table 1. Description of Variables

Dependent Variables		
S/N	**Variable Name**	**Definition**
1.	Technology Learning Indicator	Ways in which farmers acquire and build up technical knowledge and competencies. Measured as the logarithm of length of time taken by the farmer's to master the use of a particular technology
2.	Technology Utilisation Indicator	Measured as three quantitative variables where respondents were asked to pick from indigenous, modern or a mix of the two.
3.	Technology Transfer Indicator	Measured as a binary variable where farmers were asked to indicate whether they have successfully transferred the technology to other farmers
Independent Variables		
1.	Age	Measured as 6 quantitative variables indicating the ages of the farmers in years
2.	Level of Education	Indicates the highest educational qualification of the women farmers. Options include none, primary, secondary or tertiary
3.	Years of Experience	Measured as 3 quantitative variables indicating the experience in years the farmers have been engaged in agriculture
4.	Primary Occupation	An indicator of whether or not the farmers use farming as part-time job or is their main occupation. Measured via a binary variable taking value 1 if Primary occupation is farming and 0 if otherwise)
5.	Leaning Capability	Measures the strength of learning of new technologies.
6.	Availability of Learning System	A binary variable indicating whether or not the farmer has any meeting venue to share knowledge on technologies
7.	Intensity of Learning	Measured as 3 quantitative variables indicating in months the frequency of meeting to share knowledge on new technologies

An example is the two-way model which recognises that the interaction between the developer and user of technologies is crucial to successful technology generation and transfer. The user, in this case, the farmers may develop the learning capability through experience, trial and error, networking etc. They are not just passive recipient of

technologies but through the learning process adapt, assimilate, utilise and master the knowledge until they are able to improve on it and transfer it to fellow farmers and source (Nieuwenhuis, 2002). The technology source includes knowledge institutions such as universities and research institutes. This study adapts this model, however, with slight modifications (Figure 3). It assumes that the users do not just have the capability to learn and influence the process of technology transfer but also have the capability to use their indigenous knowledge and technologies to meet their needs. It also acknowledges the role of technology facilitators. These are bridging institutions that facilitate the process of interaction, learning and transfer between the source and user. They include NGOs, CBOs, media, extension agents etc. A key characteristic of this model is that the roles of the key actors are less stereotyped and therefore interchangeable (Roling, 1990).

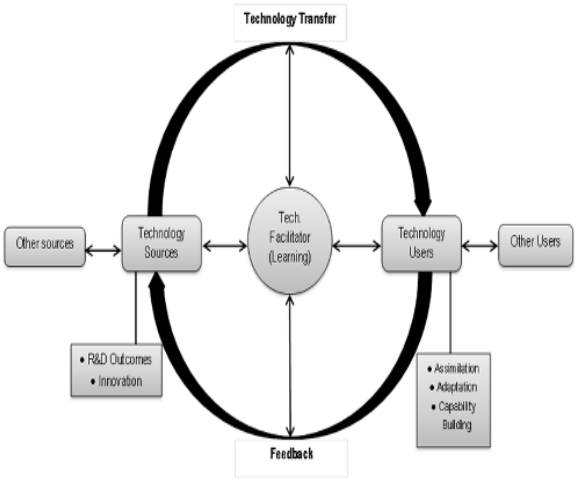

Fig. 3.Conceptual Framework for technology transfer
Source: Adapted from Roling, 1990

RESULTS AND DISCUSSIONS

a)Demographic Characteristics

Of the 128 women farmers who returned valid questionnaires, majority of them, about 36%, are in the mid-age categories between 41 to 50. The least age categories are the ones under the age of 20 with only 1 respondent (Table 2). Every three in five of the women farmers are married while those with secondary education are in the majority with slightly less than 2 in 5 women farmers. Only about 1 in 7 of these farmers has tertiary education and thus constituting the least education category. About two-third of them practiced farming as their primary occupation while the remaining are primarily traders, artisans with a few civil servants. About half of the respondents are experienced farmers having been practicing for more than 10 years. This shows that majority of the smallholder women farmers are primarily farmers of mid-age, semi-educated and have built strong capability in farming. This finding is similar to previous studies of Nigerian smallholder women farmers. For example, Osungiri *etal.*, (2012) found out in a study of smallholder farmers in the South Eastern zone of Nigeria that the average experience and highest academic qualification of 13 years and primary school respectively.

Table 2. Demographic Characteristics of Smallholder Women Farmers

Age	**%**
20 and below	0.8
21-30	8.6
31-40	25.0
41-50	35.9
51-60	27.3
Above 60	2.3
Marital Status	
Single	6.3
Married	61.7
Widowed	27.3
Divorced	3.9
Level of Education	
None	17.6
Primary	32.8
Secondary	36.0
Tertiary	13.6
Years of Experience	
Less than 5	14.6
5 – 10	36.6
Above 10	48.8
Primary Occupation	
Farming	66.4
Non-Farming	33.6

In the same zone, another study of smallholder women farmers reported an average age of 51, 11 years education and 10

years farming experience (Dimelu *et al.*, 2009). These confirmed earlier studies that smallholder farming is not attractive to young, single and highly educated women (Osugiri *et al.*, 2012).

Table 3. Agricultural Practice by Women Farmers

Agricultural Practice	**%***
Food Crop Production	32.8
Cash Crop Production	13.3
Horticultural Crop Production	11.7
Livestock Production	29.7
Livestock and Crop Production	10.9
Crop Processing	9.4

* Multiple Response Analysis

Majority of the respondents are engaged in food crop production followed by livestock production. Crop processing attracted the least respondents (Table 3).

b)System of Technology Learning and Utilisation

Women farmers utilised indigenous technologies more than modern technologies (Table 4). About two-third of the farmers use indigenous technologies in their farming practices while about 1 in 6 utilised modern technologies.

Table 4. Technology Utilisation by Women Farmers

Technology Type	**%**
Indigenous technology	66.7
Modern technology	17.1
Both	16.3

Family and parents constitute the main source of knowledge used in indigenous technologies while the media through programmes and television and radio constitute the least (Table 5). The knowledge sources through extension agents are not an important source of knowledge for learning indigenous technologies among the smallholder farmers. However, though majority of the farmers utilised indigenous technologies, extension agents play a key role in knowledge source. This is followed by other farmers. This is not surprising as many farmers tend to adopt the modern technologies after initial success with fellow farmers.

Indigenous technologies are learnt mainly through oral instruction mainly from parents and family members and fellow farmers. Learning by doing through trial and error constitutes another major channel (Table 6).

Table 5. Sources of Leaning of Indigenous and Modern Technologies

Indigenous Technologies	%*
Parents and Family Members	79.0
Other Farmers	51.0
Extension Agents	17.0
Agricultural programmes on TV, Radio etc.	5.0
Modern Technologies	
Extension Agents	58.3
Other Farmers	50.0
Agricultural programmes on TV, Radio etc.	47.2
Universities/Research Institutes	30.9

* Multiple Response Analysis

The introduction of technologies like telephone has not imparted on the knowledge accumulation process of the farmers. Despite the high penetration in mobile phone telephone in Nigeria in the last 10 years, most farmers though use phone in their day-to-day activities have not found it useful for knowledge sharing.

Table 6. Modes of Leaning of Indigenous and Modern Technologies

Indigenous Technologies	%*
Oral Instruction	66.7
Learning by Doing	55.6
Learning by Observation	52.5
Phone Discussion	1.0
Modern Technologies	
Learning by Doing	63.2
Oral Instruction	60.5
Learning by Observation	52.6
Farm Visitation	44.7
Seminar and Workshop	42.1
Phone Discussion	15.8

* Multiple Response Analysis

Majority of the farmers prefer market and their associations as avenue for knowledge sharing and learning (Table 7). This enhances interaction with different actors crucial to the learning and transfer of new technologies.

b)Drivers of Technology Learning and Utilisation

The drivers of technology learning and utilisation are shown in Table 8. As reviewed in the literature, a key component of technology use is learning.

Table 7. System for Technology Transfer among Women Farmers

Avenue for Knowledge Sharing*	%
Market	53.8
Farmers Association	44.2
On the Farm	27.9
Others	2.9
Frequency of Meeting	
Once a month	61.3
Once in three months	33.3
Once in six months	2.2
Once a year	3.2

* Multiple Response Analysis

We argue based on our results that technology utilisation is accompanied by learning. This argument is confirmed with the figures from Table 8 showing a positive correlation between these two variables ($r = 0.168$; $p<0.01$). Table 8 reveals that more variables are significantly correlated with technology utilisation than learning. Specifically, four variables have significant correlation with technology utilisation while two variables are significantly correlated with technology learning. Age, level of education, years of experience and intensity of learning are significantly correlated with technology utilisation at 1% level of confidence while primary occupation and intensity of learning have significant correlation with technology learning at 5% and 1% level of confidence respectively.

A close examination of Table 8 reveals that while age and years of experience are negatively correlated with technology utilisation, level of education and intensity of learning are positive. This shows that as women farmers become older and more experienced, they tend to use indigenous technologies more than modern ones. It also reveals that educated women farmers use modern technologies more than indigenous ones.

Also, the more frequently the farmers are exposed to training, both formally and informally, the higher the level of utilisation of modern technologies.

Years of experience of women farmers has a significant negative correlation with technology learning at 5% confidence level, whereas, intensity of learning is positively correlated at 1% confidence level. This shows that women farmers tend to master new technologies if they have the opportunities of frequent knowledge sharing and training sessions.

Table 8. Drivers of Technology Utilisation and Learning

S/N	**Variables**	**Correlation Coefficient***	
		Technology Utilisation Indicator	Technology Learning Indicator
Dependent			
1	Technology Learning Indicator	1	0.164
2	Technology Utilisation Indicator	0.164	1
Independent			
1	Age	-0.276**	-0.083
2	Level of Education	0.489**	0.179
3	Years of Experience	-0.315**	-0.048
4	Primary Occupation	0.039	-0.188*
5	Transfer Capability	0.036	0.091
6	Availability of Learning System	0.104	-0.014
7	Intensity of Learning	0.367**	0.339**

Also, those with farming as their primary and main source of income master new technologies within a shorter length of time than those who take farming as secondary activities. These are farmers who are primarily traders, artisans, and even in some cases, civil servants.

The fact that learning intensity is strongly and positively correlated with both technology learning and utilisation shows its important. However, fora such as association meetings, farm, market etc. which allow interaction

among the actors enhance learning and subsequently utilisation of new technologies (Roling, 1990). The market is important because it allows farmers to interact directly with different actors such as customers and other farmers. The farmers' association meeting allows extension agents, successful farmers, CBOs and NGOs to have the opportunity to directly share information about new technologies. It also enhances feedback and builds farmers capacity to assimilate, utilise and master new technologies. However, learning intensity and variety of sources for learning are believed to be more important to the process of learning and utilisation. A one-off training or knowledge sharing platform may not be adequate in the learning process. Table 7 reveals that two-thirds of the farmers meet once a month to share and discuss new technologies. The intensity of learning provided by repeatability and frequency as well as variety of learning sharing platforms enhance the process of learning and utilising new technologies (Bozeman, 2000).

b)Drivers of Technology Transfer

To transform from being the user to source of technologies, a farmer has to learn, use and assimilate new knowledge. Table 9 reveals that age, years of experience and the availability of platforms for learning are significantly correlated with technology transfer. While farmers' age and experience are negatively correlated at 1% and 5% confidence level respectively, availability of learning system is positively correlated at 1% confidence level.

We can infer from these that it is more difficult to transfer new technologies to older women farmers than the younger ones. We regroup age classifications into two: youth and elderly. All farmers below the age of 40 are classified as youth while those from 40 are regarded as elderly. Our findings reveal that there is a high dependence on indigenous technologies for farming activities among older women. However, there is a rising interest in the utilisation of new technologies among younger women (Table 10).

The resistance in using new technologies among older women may be attributed to old age and inability of new technologies to meet their needs (Gul Unal, 2008; Kaimowitz, *etal.*, 1990). Furthermore, Table 9 reveals that the availability of learning system enhances transfer of new technologies.

Table 9. Drivers of Technology Transfer

S/N	Variables	Correlation Coefficient*
Dependent		
1	Technology Transfer Indicator	
Independent		
1	Age	-0.178*
2	Level of Education	0.098
3	Years of Experience	-0.427**
4	Primary Occupation	0.130
5	Availability of Learning System	0.414**
6	Intensity of Learning	0.083
7	Learning Capability	0.058

* indicates significance at 5% level and ** 1% level of confidence

Table 10. Technology Utilisation Disaggregated by Age and Years of Experience

	Technology Utilisation (%)		
Age Group	Indigenous	Modern	Mix
Youth	48.8	34.9	16.3
Elderly	76.3	7.5	16.3
Years of experience			
Less than 5	55.6	16.7	27.8
5 – 10	46.3	34.1	19.5
Above 10	83.1	5.1	11.1

This shows that more women will adopt and transfer new technologies if there are effective mechanisms for sharing knowledge and learning.

CONCLUSIONS

The study of smallholder women farmers has implications for policy since majority of Nigerian farmers are smallholders with women constituting between 60 to 80%. The findings from this study, though with a relatively small sample, can provide useful conclusions with implications for policy in developing country context. It can also serve as a model for a broader study.

The study reveals that the key drivers of technology utilisation are age, level of education, years of experience and learning intensity. This implies that indigenous technologies should be integrated into research so that it can be attractive to the older women. Also, the introduction of new technologies should be need and gender-specific. Farmers should be involved as key actors in the research and development process. This will help in sustaining the rising interest of younger women in adapting modern and indigenous technologies in agriculture. The variety and intensity of learning sources have been shown to be crucial factors enhancing learning and utilisation of new technologies. Hence, there is the need for deeper and broader interactions among key actors, such as, R&D institutions, extension agents, NGOs, CBOs and farmers on the effectiveness and variety of channels of knowledge sharing used in technology learning, utilisation and transfer. Appropriate public policy interventions should also be introduced to develop 'smallholder-friendly' technologies, especially among women, to curb market failures in technology adoption.

ACKNOWLEDGMENTS

We acknowledge the support of organisations and people who played different roles in this research. These include the African Women in Agricultural R&D (AWARD), Ogun-Osun River Basin Authority and Farmers Development Union (FADU), Ibadan. Others include Simi Oluwusi, Tolu, Jacob Opele, Omolayo Oluwatope, Abiodun Egbetokun, Caleb Adelowo, Femi Akindimeji, Godwin Ali and Maruf Sanni.

REFERENCES

[1] ActionAid, 2011. Investing in Women Smallholder Farmers: An ActionAid International Briefing.
[2] Adesina, A.A., Baidu-Forson, J., 1995, Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. Agricultural Economics 13 (1995) p. 1-9
[3]Beintema, N., Stads, G.J., 2011, African agricultural R&D in the new millennium: progress for some, challenges for many. IFPRI Food Policy Report. Washington, DC: International Food Policy Research Institute and Agricultural Science and Technology Indicators. Rome, Italy
[4]Birner, R., Anderson, J.R., 2007, How to make agricultural extension demand-driven? The case of India's agricultural extension policy. IFPRI Discussion Paper 00729, Development Strategy and Governance Division, IFPRI.
[5] Bozeman, B., 2000, Technology transfer and public policy: A review of research and theory. Research Policy, 29, p. 627-655.
[6]Dimelu, M. U., Okoye, A. C., Okoye, B. C., Agwu, A. E., Aniedu, O. C., Akinpelu A. O., 2009, Determinants of gender efficiency of small-holder cocoyam farmers in Nsukka agricultural zone of Enugu State Nigeria. Scientific Research and Essay, 4(1), p. 028-032.
[7]Doss, C. R., 2001, Designing agricultural technology for African women farmers: Lessons from 25 years of experience. World Development 29 (12), p. 2075–2092.
[8] Figueiredo, P.N., 2002, Learning processes features and technological capability accumulation: Explaining inter-firm differences. Technovation 22(11) 685–698
[9] Flaherty, K., Ayoola, G., Ogbodo, J., Beintema. N. M., 2010. Nigeria. ASTI Country Note. Washington, DC, and Abuja: International Food Policy Research Institute, Agricultural Research Council of Nigeria, and Farm and Infrastructure Foundation.
[10] Gul Unal, F., 2008, Small is beautiful: evidence of an inverse relationship between farm size and yield in turkey. Working Paper No. 551, The Levy Economics Institute NY.
[11] IFAD, 2012. Sustainable smallholder agriculture: feeding the world, protecting the planet Proceedings of the Governing Council Events In conjunction with the Thirty-fifth Session of IFAD's Governing Council, February 2012: http://www.ifad.org/events/gc/35/doc /proceeding.pdf
[12] IFPRI 2002. Ending hunger in Africa: Only the small farmer can do it. http://ageconsearch.umn.edu/ bitstream/15914/1/mi02en01.pdf
[13] Kaimowitz, D., Snyder, M., Engel P., A., 1990, Conceptual Framework for Studying the Links between Agricultural Research and Technology Transfer in Developing Countries in Kaimowitz D. (ed.) making the link: agricultural research and technology transfer in developing countries p. 1-43 International Service for National Agricultural Research (ISNAR) Boulder, San Francisco & London: Westview Press
[14] Komolong, M.K., Omuru, E.E., Mbabu, A.N., 2012, The evolution of the agricultural sector in PNG in Mbabu A.N. and Hall A. (eds.) Capacity building for agricultural research for development: lessons from practice in Papua New Guinea (p 40 – 54). United Nations University-Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT), Maastricht: The Netherlands.

[15] Lipton, M., 1988. The place of agricultural research in the development of Sub-Saharan Africa. World Development, 16 (10), p. 1231–57.
[16]Madukwe, M.C., Okoli, E.C., Eze, S.O., 2002. Analysis and comparison of the agricultural development programme and university agricultural technology transfer systems in Nigeria (ATPS Working Paper Series No. 35). African Technology Policy Studies Network. www.atpsnet.org/files/ working_paper_series_35.pdf
[17]NACETEM 2012. Nigeria's research and development survey 2006/07 (1st Edition). National Centre for Technology Management, Ile-Ife.
[18]Nieuwenhuis, L.F.M., 2002, Innovation and learning and agriculture. Journal of European Industrial Training, 26(6), p. 282 - 291
[19] NBS 2011, The review of the Nigerian economy 2010. National Bureau of Statistics. Abuja.
NBS 2012. Annual socio-economic report. National Bureau of Statistics. Abuja.
[20] Odebode, S.O., 2002, Effective communication methods in technology transfer: Nigeria sweet potato processors experience. International Association of Agricultural Information Specialists Quarterly Bulletin 47(3-4) p. 96-98
[21]Okoye, B.C., Okoye, A.C., Asumugha, G.N., Dimelu, M.U., Agwu, A.E., Agbaeze, C.C., 2008, Determinants of gender productivity among small-holder cocoyam farmers' in Nsukka agricultural zone of Enugu State, Nigeria (MPRA Paper No. 17500)
[22]Osugiri, I.I, Albert, I.U., Onyaguocha, S.U.O., Onyemauwa, C.S., Ben-Chendo, G.N. ,2012, Population dynamics, labour and small-holder farmers' productivity in Southeast Nigeria. Journal of Economics and Sustainable Development, 3(12)
[23]Onuba, I. 2012, February 14. 112.5 million Nigerians live in poverty –NBS. The Punch Newspaper. http://www.punchng.com/business/ business-economy/112-5-million-nigerians-live-in-poverty-nbs/
[24]Oyelaran-Oyeyinka B.,2002, Learning and local knowledge institutions in African industry', UNU-INTECH discussion paper 02, United Nations University, Maastricht, Netherlands
[25] Palis F.G., 2006, The role of culture in farmer learning and technology adoption: A case study of farmer field schools among rice farmers in central Luzon, Philippines. Agriculture and Human Values, 23(4) p. 491-500
[26]Ramanathan, K.,1994, The polytrophic components of manufacturing technology. Technological Forecasting & Social Change, 46, 221-258.
Ramanathan, n.d. An overview of technology transfer and technology transfer models
[27]Roling N., 1990, The agricultural research-technology transfer interface: a knowledge systems perspective in Kaimowitz D. (ed.) making the link: agricultural research and technology transfer in developing countries p. 1-43 International Service for National Agricultural Research (ISNAR) Boulder, San Francisco & London: Westview Press
[28]Saka, J.O., Okoruwa, V.O., Lawal, B.O., Ajijola S., 2005, Adoption of improved rice varieties among small-holder farmers in South-western Nigeria. World Journal of Agricultural Sciences 1 (1), p42-49