Article

Factors Preventing the Adoption of Agricultural Technology among Banana and Plantain Growers: A Mapping Review of Recent Literature

Balogun Daud Ishola[1]*, and Nalini Arumugam [2]

1 Affiliation [2]; nalini@unisza.edu.my
* Correspondence: daud4us2002@gmail.com

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Abstract: It is believed that improved agricultural technology adoption, such as using improved seed varieties, fertilizer application could stimulate the changeover from the presently low productivity, peasant, and subsistence farming to commercial farming which is able to produce surpluses. However, the rate of adoption of these technologies in developing countries has remained low. This paper aims at shedding some light on the potential factors that preventing agricultural technology adoption among Banana and Plantain growers. It does so by reviewing previous studies done on technology adoption. Technological, economic, institutional factors and social factors are found to be the determinants of agricultural adoption**.** Therefore, this review paper has the aim to identify the factors preventing the adoption of Agricultural technology in recent Literature**.** Twenty articles were selected from (2013 onward) upon screening and mapping review was conducted**.** The reviewed paper on adoption to widen the range of variables used by including Subsidy policy and cost of technology towards new technology.

Keywords: Technology; Adoption; Banana; Plantain Growers

About the Authors

Balogun Daud Ishola graduated from Federal University of Agriculture Abeokuta Ogun State, Nigeria (BSC) and also having Higher National Diploma (HND) in Agricultural Extension and Management at Federal College of Forestry Jericho Ibadan Oyo state, Nigeria. Daud is currently a Master student with the discipline of Agricultural Economics, Universiti Sultan Zainal Abidin, Malaysia. His research interest includes adoption, efficiency and impact evaluation studies.

Public Interest Statement

Since the advent of Improved Agricultural Technology in agriculture has resulted to increase in Agricultural production by farmers worldwide. The development of these Improved Agricultural Technologies is mainly to increase farm income and productivity, reducing malnutrition and hunger, and eradicate food insecurity, particularly among developing economies countries like Nigeria. However, it has shown by researchers that in smallholder farming communities in developing countries, adoption of Improved Agricultural Technology is relatively low. This review paper investigates the factors preventing the adoption of agricultural technology that had been identified by many recent authors. Empirical findings from the study confirmed that farmers' socioeconomic characteristics, institutional, Social, Economic and policy factors significantly influence the adoption of Improved Agricultural Technology. The review paper, therefore, recommends that farm-level strategies oriented toward the adoption of Improved Agricultural Technology,

in general, is very crucial to enhance productivity growth in the developing countries agricultural economy.

1. Introduction

Agriculture in Nigeria is the backbone of the economy and through this, over 75% of the population are being employed. The growth rate that is above 5% has also recorded through this sector in current years compare to the growth rate of less than 2% recorded in the early '80s (Falusi, 2008). The demand for banana or plantain is all year round despite that in Nigeria, good quality banana or plantain is produced mainly during October to February every year (Adewunmi et al. 2009). Plantain production in Nigeria is mainly in the Southern states which include Delta, Enugu, Osun, Rivers, Edo, Imo, Oyo, Akwa - Ibom, Ogun, Cross River, and Lagos states (Ogazi,1996). The standard maturity stage for banana is more precise than they are for plantain. Several characteristics of different external and internal fruit are used to examine Plantain maturity by various attributes of different external and internal fruit. These include the length of the fruit, peel color, the sharpness of the fruit, fruit diameter, and age of the bunch (Johnson et al. 1998). The intended market destination determines the stage of maturity for harvesting (Johnson et al. 1998). Export advertised plantains can be hoard at an early stage of maturity compared to Locally merchandised fruit which can be hoard at a more advanced maturity stage. Export market destined fruit should be harvested the day before or the same day of shipment (Ogazi, 1996). Plantain maturity is interrelated to the diameter of the fingers. It is strongminded by measuring the thickness of the fruit at its mid-point with a pair of callipers (Ogazi, 1996).

2. Literature Review

2.1. Technology adoption

Technology: the methods and means of manufacturing goods and services, including physical technique as well as methods of organization. New technology is 'new' to a group of farmers or a particular place or represents a 'new' use of technology that is already in use amongst a group of farmers or within a particular place (Loevinsohn *et. al*. 2013).

Adoption, on the other hand, is also defined in different ways by various authors. Loevinsohn et al. (2013) defines adoption as the integration of new technology into existing practice and is usually continue by a period of 'trying' and some degree of adaptation. Adoption is in two categories; the rate of adoption and intensity of adoption. The former is the relative rate at which farmers adopt an innovation, has as one of its pillars, the element of 'time'. Technology adoption is a complex task because it varies with the technology being adopted. Adoption of agricultural technologies defines as the decision to apply technology and to continue with its use. The agricultural economists, extensionists and rural sociologists have long been of interest in the importance of farmers' adoption of new agricultural technology. It means the definition is definitely based on the fact that the farmer is either an adopter of the technologies or non-adopter taking values zero and one or the reply is continuous variable (Challa, 2013).

Two categories of adoption are; the rate of adoption and intensity of adoption, the former is the relative rate at which farmers adopt an innovation, as one of its pillars, the element of 'time'. Differently, the intensity of adoption indicates the level of use of a given technology at a point in time (Bonabana -Wabbi 2002). According to Rogers (2003), the adoption of technology suggests the continuous use of technology. Also, that adoption deduces a change from one state to another which is affected by factors that can either obstruct or foster the adoption of the technology or group of technologies that can come in a package. Doss (2006) suggests that the adoption of technologies is a change in behaviour that ultimately leads to acceptance or rejection of that technology. Adoption of enhanced technologies or innovations is a desire to change a prevailing situation.

2.2. Factors of agricultural technology adoption.

A range of factors which influenced the rate of agricultural technologies adoption has been broadly categorized into; economic, social and institutional factors (Mamudu et al. 2012). Land size, the initial cost of a technology or its expected benefits after adoption versus the cost incurred during adoption and the farmers‟ income levels from other off-farm economic activities are all the economic factors which have been identified. Social factors that have identified to influence the chances of adoption by a farmer include; the farmer's age, level of education, gender, and his social groupings. Institutional factors that influence and determine the rate of agricultural technologies adoption and uptake by farmers include; access to information about the technologies through the existing and accessible information sources, nature of policies and provisions enacted by the government and access and nature of the extension services provided.

In a study of Langat et al. (2013) having access to the plantlets could no longer possible for those farmers who had earlier accessed to Tissue Culture banana in Bungoma district because the hardening orchards were no longer in existence. Farmers lack access to inputs and/or where to sell their produce because there were no organized marketing organizations. Closeness to main Markets was also the main issue, as most of the farmers sold their yield at the farm gate. Another major challenge in banana production is pests and diseases which prompt to apply biological and IPM (Integrated Pest Management) in the control of pests and diseases.

2.2.1 Technology factors

Characteristic of technology is a precondition of adopting it. A degree at which a probable adopter can give a trial on a small scale first before accepting it from beginning to the end is a major determinants of technology adoption (Doss, 2003). According to Mignouna *et al*. (2011) who revealed that, the features of the technology are the reasons for adopting Imazapyr-Resistant maize (IRM) technology in Western Kenya, which plays a critical role in the adoption decision process. They argued that farmers who identify the technology being consistent with their needs as well as suitable are likely to adopt technology since they find it as a positive investment to their environment. The techniques performance is significantly influenced the farmers' perception to adopt them. The farmers' perception of a characteristic of modern rice variety significantly affected their decision to adopt it (Adesina and Zinnah 1993). According to Wandji et al. (2012) who concluded that the more farmers accept technology cost to establish fish farming, the more they convinced that fish farming is the most lucrative agricultural activities. They gave an account of this when studying the perception of farmers towards the adoption of Aquaculture technology in Cameroon. This farmers' perception of the performance of the technologies as a factor influencing the adoption of agricultural technology needs to be in the future study as recent research on this factor is very shallow.

2.2.2 Economic Factors

In term of economic Land size, the initial cost of technology, expected benefits after adoption, the cost incurred during adoption and the farmers' income levels from other off-farm economic activities are all the economic factors which have been identified (Mamudu et al., 2012). The findings indicated that the farmers' age, educational status, household size, farm size, extension visit, and farmers' income showed a significant relationship with the farmers' level of adoption of the technologies (Olumba & Rahji, 2014). The proportion of income received from banana significantly affect adoption of Tissue Culture Banana (TCB), implying that income from banana sales allow farmers to grow TCB. Thus, the higher the proportion of banana revenue at the household level, the higher the adoption of TCB innovation. This could be attributed to the fact that farmers were interested in income-generating farm enterprises in order to meet household financial obligations (Wanyama et al., 2016)**.** Credit use in some studies has been ascertained to have a positive influence on adoption of SAPs (Kassie et al., 2013); Ngombe et al., 2014); Okuthe (2014) but the study of Wollni and Andersson (2014) found it to have a negative influence on the adoption.

Adoption of modern agricultural technology is affected by land size which is a critical factor of agricultural production. Similarly, in Bihar India, Singh et al. (2014) found out that the main limiting

factor to the adoption of modern horticultural technologies were too much-fragmented land as well as the small-sized land holdings, that is farmers with smaller land holdings will not take any risk to adopt new technology. A constraint to technology adoption is the cost of adopting agricultural technology. Comparatively, Since the 1990s the eradication of subsidies on prices of seed and fertilizers has widened this constraint in sub-Saharan Africa, due to the World Bank-sponsored structural adjustment programs (Muzari et al., 2012). According to (Diiro, 2013) Source of liquid capital for purchasing productivity-enhancing inputs such as fertilizer and improved seed for the Farmers is off-farm income.

2.2.3 Social Factors

The farmers' age, level of education, gender, and his social groupings have been identified as social factors that influence the chances of Farmers' adoption (Mamudu et al., 2012). Farmer groups in overall finding have been demonstrated as an appropriate channel to enhance the early adoption of agricultural technologies and improve farm-level productivity **(**Ainembabazi et al., 2015). According to Kariyasa and Dewi (2013), older farmers are believed to have gained knowledge and experience over time and are better able to assess technical information than younger farmers. On the contrary, age has been found to have a negative relationship with the adoption of technology. Education of the farmer has been believed to have a positive effect on farmers' decision to adopt new technology. Adoption of new technology is influenced by education level of a farmer because as his education level increases his ability to obtain; process and use (Namara et al., 2013). Technologies by fish farmers found that adoption of technology is positively and significantly influenced by the level of education. This eases the introduction of a new innovation which ultimately affects the adoption process (Adebiyi & Okunlola, 2013).

Agricultural knowledge oriented education system in the rural areas of Bangladesh needs to be expanded in order to increase the technology adoption level as well as its utilization to the fullest extent (Sani et al., 2014). However, more emphasis has been laid on the knowledge stock of human capital by endogenous growth models (Manda et al., 2015). Wole (2015) concluded that socioeconomic factors such as farming experience, distance to the nearest market center, age, household size, farm size and level of education were the factors that determine the adoption decision of improved maize varieties while the level of education, age, off-farm income, household size, frequency of contact with extension agent, membership in associations and farm size were the key socioeconomic factors influencing the use of intensity.

2.2.4 Institutional Factors

Institutional factors that influence and determine the rate of technologies adoption and uptake by farmers include; accessible information sources, and access and nature of the extension services provided, nature of policies and provisions enact by the government (Mamudu et al., 2012).

Small-scale farmers being having access to available extension services has a greater effect on the rate of adoption of new modern farming technologies because extension services stimulate the learning and appreciation process of the technologies being disseminated. Charles et al. (2017) concluded that availability of extension services was a significant factor in influencing adoption of Tissue Culture Banana (TCB) in the study areas and that those households require practical training through demonstrations and extension services to improve productivity and adoption of Tc bananas. The information sources mentioned were categorized into four groups namely; face-to-face communication sources, community social networks sources, mainstream media sources and modern ICT tools information sources. Information sources available to farmers are different types through which they can facilitate the adoption as well as have access to information on modern agricultural technologies. The constraint of the high cost of planting materials could be addressed by a policy which aims at reducing the cost per sucker that was facing 29.8% of the respondents. An agricultural policy that enhances the adoption of production technologies will be beneficial to increase productivity (Wanyama, et al., 2016).

3. Methodology

Adoption, Technology, Plantain, and Banana growers were used as keywords to search relevant articles in Google and Google scholar site. Only recent studies (2013 onward) involving Plantain and Banana growers were selected for review. All studies selected are prompt to open access in the web. A reasonable number of articles from various Countries including Nigeria, Western Kenya, Cameroon, Ghana. Tanzania, Tunisia, Briton UK, Zambia, and Sri Lanka were reviewed for the factors preventing the adoption of agricultural technology. As review paper's target is to seek and sort factors preventing modern technology, systematic mapping review method was selected. As many studies have been done regarding this topic, twenty articles were reviewed after screening. Below is the table showing the authors of the reviewed articles on their topics and years.

Table 1: Details of Reviewed Articles (2013-2018)

AUTHORS	TITLE	YEARS
Abbas, A. & Yuansheng, J.	Factors influencing the adoption of improved wheat varieties by rural households in Sindh, Pakistan	2018
Adebiyi, S., & Okunlola, J.	Factors affecting adoption of cocoa farm rehabilitation techniques in the Oyo State of Nigeria.	2013
Ainembabazi, J. H., Piet, V. A., Bernard, V., Emily, O., Guy B., Eliud, A. B., Victor M., & Ibrahim, M.	Improving the adoption of agricultural technologies and Farm performance through farmer groups: Evidence from the Great Lakes Region of Africa	2015
Charles, N. T., Simon, N., & Patrick, K.	Factors Affecting Adoption of Tissue Culture Bananas in the Semi-Arid Areas of Lower Eastern Region of Kenya	2017
Gideon, D., Joshua, A., Dennis, S., & Franklin, N	Adoption of improved maize variety among farm households in the northern region of Ghana	2017
Kariyasa, K., & Dewi, Y. A.	Analysis of factors affecting the adoption of integrated crop management farmer field school (ICM-FFS) in swampy areas.	2013
Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., & Mekuria, M.	Adoption of Interrelated Sustainable Agricultural Practices in Smallholder Systems:	2013
Levison, R.	Factors Influencing the Adoption of Organic Fertilizers in Vegetable Production in Accra, Ghana	2013
Manda, J. A.D., Alene, C., Gardebroek, Kassie. M., & Tembo,G.	Adopt and Impacts of Sustainable Agricultural Practices on Maize Yields and Incomes Evidence from Rural Zambia	2016
Margaret, M., & Samuel, K	Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Country	2015
Mittal, S., & Mehar, M.	Socio-economic Factors Affecting Adoption of Modern Information and Communication Technology by Farmers in India	2015
N'daghu, N. N., Zakaria, A., Shehu, R., And Tahirou, A	Socio-economic factors affecting adoption of early maturing maize varieties by small-scale farmers in Safana Local Government Area of Katsina State, Nigeria	2015
N'gombe, J., Kalinda, T., Tembo, G., & Kuntashula, E.	Econometric Analysis of the Factors That Affect Adoption of Conservation Farming Practices by Smallholder Farmers in Zambia	2014
Onyeneke, R. U.	Determinants of Adoption of Improved Technologies in Rice Production in Imo State, Nigeria.	2017
Olumba, C.C. & Rahji,M.A.Y	An Analysis of the Determinants of the Adoption of Improved Plantain Technologies in Anambra State, Nigeria	2014
Raju, G., Huang, W.,& Rudra, B. S	Factors Affecting Adoption of Improved Rice Varieties Among Rural Farm Households in Central Nepal.	2015

Sani, A, Abubakar, B.Z., Yakubu, D.H., Atala, T.K., & Abubakar, L.	Socio-Economic Factors Influencing Adoption of Dual-Purpose Cowpea Production Technologies in Bichi Local Government Area of Kano State, Nigeria.	2014
Sunday, O.	Factors influencing Adoption of Improved Soybean Production technologies among Farmers two Local Government Areas of Kogi State.	2016
Wole, I. K.	Determinants of adoption of improved maize varieties in Osun State, Nigeria	2015
Wollni, M., & Andersson, C.	Spatial patterns of organic agriculture adoption: Evidence from Honduras.	2014

4. Findings

Findings of this review paper had been done using the findings of nothing less than twenty articles to identify factors influencing the adoption of agricultural technologies.

Socioeconomic factors such as farming experience, distance to the nearest market center, age, household size, farm size and level of education were the factors that determine the adoption decision of improved maize varieties while the level of education, age, off-farm income, household size, frequency of contact with extension agent, membership in associations and farm size were the key socioeconomic factors influencing the use of intensity (Wole, 2015). This is in line with the conclusion made by Onyeneke (2017), Gideon et al. (2017) and N'daghu et al. (2015) which were all concluded that the factors influencing the adoption of agricultural technology were the household size, membership of Farmer- Based Organization, workshop attendance, amount of labor, education, experience, extension contacts, age of the household head, previous income, distance, farm size, and participation in farm demonstration. Ainembabazi et al. (2015) demonstrated in their overall findings that, an appropriate channel to boost early adoption of agricultural technologies and one of the ways to improve farm productivity level is by farmers' group. This could be achieved in three ways through increases in both extension service delivery and Farmer-based Organization (FBO), promotion of farmer-participatory methods in technology appraisal and selection, and improvement of an extension strategy and dissemination which guarantees sustainable service delivery to increase adoption of technologies. Adebiyi and Okunlola (2013) identified Farming experience and farm size as the two major factors affecting agricultural technology whereas N'gombe et al. (2014) concluded that factors influencing the adoption were off-farm income whether through access to loan or kind and access to vehicles passable roads.

Farmers' adoption was positively and significantly influenced by access to credit, extension contact, farming experience, education, tube-well ownership, landholding size, Farmers' income and household size in the study area (Olumba & Rahji, 2014); Sunday, 2016); Abbas & Yuansheng, 2018). The risk associated with adoption of technologies, profitability and their ability to produce instant benefits to meet urgent livelihood needs of the resource-poor farmers are the factors influencing the adoption of sustainable agricultural practices (Kassie et al., 2013). Wollni and Andersson (2014) identified social and availability of information in the neighborhood network as the major factors while social participation, extension contact and educational level of the farmers influenced the adoption of agricultural technology. Agricultural technology adoption of Dual-Purpose Cowpea (DPC) is influenced by socio-economic factors such as farmer's social participation, extension contact and educational level of the farmers in Bichi Local Government Area of Kano State, Nigeria (Sani et al., 2014).

According to Charles et al. (2017), socioeconomic factors like access to the market, gender, education, availability of extension services, land size, environmental factors, subsidy policy, and income level were all found to be very significant factors in determining adoption of tissue culture technology in the study area. A study conducted by Margeret et al. (2015) slightly deviated from previous studies who concluded that, a key precondition for adoption to occur is the perception of

farmers and farm size may have positive effect on adoption of a certain technology and it may also show a negative impact on adoption of another technology such as zero grazing technology.

The study of Raju et al. (2015) revealed that the factors affecting the probability of adoption are seed access, yield potential, consumers' acceptability of rice varieties, extension service, farm size, and education. Socio-economic characteristics of farmers such as level of education, farm size, and age were identified as major factors affecting the adoption of technology (Mittal & Mehar 2015). Mandal et.al. (2015) found out that the propensity to adopt decreased with access to off-farm income, gender of the household head and distance to input and output markets which contradict with the previous studies by researchers such as Lavison (2013) who concluded that gender of a farmer, income generated from improved technology and market availability to the farmers were all influenced the adoption of agricultural technology likewise Kariyasa and Dewi (2013) who also revealed that information sources, level of education, distance to the meeting place, the level of productivity and age were also positively and significantly influenced the improved agricultural technologies.

5. Conclusion

In a nutshell, this study had identified and categorized the factors preventing the adoption of Agricultural Technology, they are mainly economic, Social, institutional and technology Factors. They were used to construct the research frameworks. Out of all the reviewed articles, it was only Charles et al. that included subsidy policy as a variable affecting adoption of Technology and also to encourage them to adopt improved technology. Therefore, future study should include subsidy policy and cost of technology. However, in Oyo State much had been done pertaining to the factors affecting the adoption of agricultural technology but it is unfortunate that very little had only been done on factors affecting the adoption of agricultural technology related to Plantain and Banana. It is, therefore, necessary to carry out research on factors affecting the adoption of agricultural technology and level of awareness among Plantain and Banana growers in Oyo state. This is the only way to meet up with the Plantain and Banana demand that keeps on increasing day by day.

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