



Research Article

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What Does Literature Say About the Determinants of Adoption of Agricultural Technologies by Smallholders Farmers?



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Abstract

Understanding the determinants of adoption of agricultural technologies is essential in planning and executing technology related programmes for meeting the challenges of food production in developing countries. This study therefore extensively reviewed the various factors influencing adoption of agricultural technology among smallholder farmers. Results of the findings show that changes in technology adoption are associated with changes in the economic situation of the country, financial status of farm households and the net gain from adopting the technology, access to credit, access to information, travel cost, characteristics of the technology, scale of operation of the farmers, income, cultural norms and values, social network and human specific factors. The findings will be useful to technology developers, disseminators, and the end users (farmers). To increase the likelihood of adoption of the modern agricultural technologies by smallholders, policy makers should make credit accessible to farmers without gender discriminations, make information about the technology available via extension services, advice farmers to improve their educational level and carry the end users along while developing the technology.

Keywords: Adoption; Improved agricultural technology; Determinants; Smallholder farmers;

Introduction

Agricultural technology embodies a number of important characteristics that may influence adoption decisions [1]. The literature on agricultural technology adoption is enormous [2-4] and somewhat difficult to summarize closely [5-7]. Conventionally, analysis of agricultural technology adoption focused on imperfect information, risk, uncertainty, institutional constraints, human capital, input availability, and infrastructure as potential explanations for adoption decisions [8-10]. The recent literature now focuses on social networks and learning [11] to explain factor determining adoption behaviour of agricultural technology [2,8,12]. For instance, while some studies like Akudugu [13] have classified the determinants of adoption of agricultural technology into three categories namely; economic, social and institutional factors; Kebede et al. [14] broadly categorized the factors into: social, economic and physical factors; McNamara et al. [15] categorized the factors into: farmer characteristics, farm structure,

institutional characteristics and managerial structure. Nowak [16] in his own case grouped them into informational, economic and ecological, while Wu & Babcock [17] classified them under human capital, production, policy and natural resource characteristics.

This paper discusses the determinants of agricultural technology from the traditional, social, physical, and economic perspectives. The factors are: institutional factor, technological, economics, financial, physical, human, cultural and household specific factors.

Materials and Methods

The study used a structured literature review of publications in peer reviewed academic journals on adoption of agricultural technologies. By structured literature we mean a systematic, explicit, and reproducible design for identifying, evaluating, and interpreting the existing body of knowledge.

Results and Discussion

Characteristics of the agricultural technology

Characteristic of a technology is a prerequisite of adopting it [18-20]. The degree to which a potential adopter can try something out on a small scale before adopting it completely is a major determinant of technology adoption [21]. In studying determinants of adopting Imazapyr-Resistant maize (IRM) technology in Western Kenya for instance, Mignouna et al. [22] stated that, the characteristic of the technology play a critical role in adoption decision process. They argued that farmers who perceive the technology as being consistent with their needs and compatible to their environment are likely to adopt such since they find it as a positive investment. Farmers' perception about the performance of the technologies significantly influences their decision to adopt them. Another examples is a study by Adesina & Zinnah [18] that showed that farmers' perception of the characteristic of modern rice variety significantly influenced their decision to adopt it. A similar result was reported by Wandji et al. [23] when studying perception of farmers towards adoption of Aquaculture technology in Cameroon and that of Mwangi & Kariuki [20] on factors determining adoption of new agricultural technology by smallholder farmers in developing countries. More recently, some economists and other social scientists have focused more explicitly on farmers' motivations, values, objectives and behavioural influences in the context of technology adoption [24].

Economic factors

A key determinant of the adoption of a new technology is the net gain to the farmer from adoption, inclusive of all costs of using the new technology [25]. High cost of agricultural technology has been reported hindrance to adoption agricultural technology [26]. This is supported by other previous studies such as Chi & Yamada [27], Nkonya et al. [28] on determinants of technology adoption. For instance, the elimination of subsidies on prices of seed and fertilizers since the 1990s due to the World Bank-sponsored structural adjustment programs in sub-Saharan Africa has widened this constraint [6]. The study done by Makokha et al. [29] on determinants of fertilizer and manure in maize production Kiambu county, Kenya reported high cost of labor and other inputs, unavailability of demanded packages and untimely delivery as the main constraints to fertilizer adoption. Cost of hired labor was also reported by Ouma et al. [31] as one among other factors constraining adoption of fertilizer and hybrid seed in Embu county Kenya. Wekesa et al. [30] when analyzing determinants of adoption of improved maize variety in coastal lowlands of Kenya found high cost and unavailability of seeds as one of factors responsible for low rate of adoption. Off farm income has been shown to have a positive impact on technology adoption. This is because off-farm income acts as an important strategy for overcoming credit constraints faced by the rural households in many developing countries [32]. Off-farm income is reported to act as a substitute for borrowed capital in rural economies where credit markets are either missing or dysfunctional [33]. According to Diiro [33] off- farm income is expected to provide farmers with

liquid capital for purchasing productivity enhancing inputs such as improved seed and fertilizers.

Physical factors

Physical factors such as the farm size play a critical role in adoption process of a new technology [20]. Many studies have reported a positive relation between farm size and adoption of agricultural technology [5,22,34]. Small farm size provides an incentive to adopt a technology especially in the case of an input-intensive innovation such as a labor-intensive or land-saving technology. Farmers with small land adopt land-saving technologies such as greenhouse technology, zero grazing among others as an alternative to increased agricultural production [35]. Some technologies are termed as scale-dependant because of the great importance of farm size in their adoption [36]. Farmers with large farm size are likely to adopt a new technology as they can afford to devote part of their land to try new technology unlike those with less farm size.

Human factors

Farmers are consumers of the products of agricultural research and their subjective preferences for characteristics of new agricultural technologies affect their adoption decisions [1]. Farmers are also important as sources of technology information and agents of technology transfer. The risk preferences of farmers are also important in influencing the technology adoption decision, especially if capital-intensive technology costs are irreversible [3]. When farmers assess the characteristics of new technologies and find them to match their preferences, they often give the technologies to other farmers to test and evaluate thereby setting into motion an endogenous process of technology diffusion.

Access to information and social network

Farmers need to know the existence of technology, its beneficial, and its usage for them to adopt it. Acquisition of information about a new technology is another factor that determines adoption of technology [37]. It enables farmers to learn the existence as well as the effective use of technology and this facilitates its adoption. Farmers will only adopt the technology they are aware of or have heard about it. Access to information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time. Access to information may also result to dis-adoption of the technology. For instance, where experience within the general population about a specific technology is limited, more information induces negative attitudes towards its adoption, probably because more information exposes an even bigger information vacuum hence increasing the risk associated with it Bonabana- Wabbi [36]. It is therefore important to ensure the information is reliable, consistent and accurate.

Access to extension services helps to spread information about new agricultural technology leading to adoption. Farmers are usually informed about the existence as well as the effective use and benefit of new technology through extension agents. Extension

agent acts as a link between the innovators (Researchers) of the technology and users of that technology. This helps to reduce transaction cost incurred when passing the information on the new technology to a large heterogeneous population of farmers [38]. Extension agents usually target specific farmers who are recognized as peers (farmers with whom a particular farmer interacts) exerting a direct or indirect influence on the whole population of farmers in their respective areas. Many authors have reported a positive relationship between extension services and technology adoption. A good example include; Adoption of Imazapyr-Resistant Maize Technologies (IRM) by Mignouna et al. [22]; Factors determining technology adoption among Nepalese [39]; Adoption of improved maize and land management in Uganda by Kuuma [40]; adoption of modern agricultural technologies in Ghana [13] just to mention a few. This is because exposing farmers to information based upon innovation-diffusion theory is expected to stimulate adoption. In fact, the influence of extension agents can counter balance the negative effect of lack of years of formal education in the overall decision to adopt some technologies [38].

Belonging to a social group enhances social capital allowing trust, idea and information exchange. Farmers within a social group learn the benefits and usage of a new technology from one another. Uaiene et al. [5] suggests that social network effects are important for individual decisions, and that, in the particular context of agricultural innovations, farmers share information and learn from each other. Studying the effect of community based organization in adoption of corm-paired banana technology in Uganda, Katungi and Akankwasa (41) found that farmers who participated more in community-based organizations were likely to engage in social learning about the technology hence raising their likelihood to adopt the technologies. Although many researchers have reported a positive influence of social group on technology adoption, social groups may also have a negative impact on technology adoption especially where free-riding behaviour exists. Bandiera & Rasul [42] suggests that, learning externalities generate opposite effects, such that the more other people engage in experimentation with a new technology, the more beneficial it is to join in, but also the more beneficial it is to free-ride on the experimentation of others.

Credit systems

Access to credit is found to be very important factor influencing the adoption of agricultural technology by the smallholders [43]. Credit can facilitate farm households to purchase the needed agricultural inputs and enhance their capacity to effect long-term investment in their farms. Credit access in some countries where female-headed households are discriminated against by credit institutions, prevent women who are into agriculture from adopting yield-raising technologies. leading to.

Household-specific factors

Human capital of the farmer is assumed to have a significant influence on farmers' decision to adopt new technologies [20]. Most adoption studies have attempted to measure human capital

through the farmer's education, age, gender, and household size [44,45,43]. Education of the farmer has been assumed to have a positive influence on farmers' decision to adopt new technology. Education level of a farmer increases his ability to obtain; process and use information relevant to adoption of a new technology [46,47]. For instance a study by Okunlola et al. [48] on adoption of new technologies by fish farmers and Ajewole [49] on adoption of organic fertilizers found that the level of education had a positive and significant influence on adoption of the technology. This is because higher education influences respondents' attitudes and thoughts making them more open, rational and able to analyze the benefits of the new technology [50]. This eases the introduction of a new innovation which ultimately affects the adoption process [51]. Interaction with extension services [52,53] and peer-group behaviour [54] positively impact farmers' technology adoption decisions.

Travel cost

Other parts of the social science literature emphasise the role of distance and geography in the adoption of agricultural technologies. In this case, any significant travel costs involved in the initial learning about a technology and subsequently establishing it might reduce the likelihood of that technology's adoption.

Cultural differences

Cultural differences in attitudes and unobservable characteristics play a role in the adoption process. Cultural traits enter into the agricultural technological adoption process through network formation, indirect effects such as imitation, peer effects, and norm-based diffusion. For instance, Lee [55] examined whether cultural traits affect the diffusion of agricultural technologies in developing countries using data collected in Ghana and found that farmers belonging to clans with higher proportion of adopters are more likely to adopt agricultural technology [56].

Conclusion and Recommendations

The essence of the review is to dig deep into the various factors affecting the adoption of agricultural technologies by smallholder farmers. The review had revealed a vast factors affecting smallholder farmers' decision to adopt agricultural technologies. Findings from this study had shown that adoption of agricultural technology depends on a range factors which include among others: human specific factors, social factor, cultural factor, economic factor, characteristics of the innovation itself, education levels, capital, income, farm size, access to information, utilisation of social networks, beside the cost of the inputs. It is imperative for policy makers to ensure that a wider spectrum of smallholders are able to have access to credit in order to improve their adoption level of agricultural technology. Developers of new agricultural technology should try to understand the farmers need as well as their ability to adopt technology in order to develop technology that will suit them.

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