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Review on Adoption, Impacts and Determinant Factors of Dairy Technology in Ethiopia

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Abstract
Governmental, non-governmental, private and international organizations have been engaged in promoting and disseminating dairy production technologies to smallholder farmers through various channels of extension such as technology verification and demonstrations, knowledge and skill enhancing training, experience sharing visits, farmer-to-farmer information exchange mechanisms and others. Even though the dairy technology in Ethiopia was promoted and disseminated through different organizations with the aim of improving output, increasing incomes and consequently improving the livelihoods of the small holder farmers, the adoption of dairy technologies by farm households varies widely across different agro-ecologies and within the same agro-ecology based on various technical and non-technical determinant factors which have not been compiled. Moreover, the impacts of the technologies on the farmers' livelihoods which can be used as an instrument for policy formulation in the dairy sector (breeding, marketing, health and other segments of the sector) have not been reviewed earlier. Therefore, it is an effort to review the aspect thoroughly and bring minor details into focus to have better understanding of the rate and extent of adoption, impacts and determinant factors of dairy technologies.
Keywords: Adoption, Dairy Technology, Determinant Factors, Ethiopia, Impacts

1. Introduction

With more than 59.5million cattle, 30.70million sheep, 30.20million goats, 2.16million horses, 8.44million donkeys, 0.41million mules, and about 1.21million camels and 56.53million poultry, Ethiopia is the largest livestock producer in Africa (CSA, 2017). In spite of the large livestock population, the contribution of the Ethiopian livestock sector in general and the dairy sector in particular is below its potential at both the national and household level (Behnkle, 2010). This low production level of the sector is attributed to inefficient productivity of the livestock as a result of the traditional method of production, poor breeds, poor feeding, inferior health care and services, and low capital investment in human and fixed assets (Zegeye, 2003).

According to the central statistical agency estimation (CSA, 2017), the total cow milk production (excluding milk suckled) for the rural sedentary areas of the country during the reference period, is about 3.1 billion liters, average lactation period per cow during the reference period at country level was estimated to be about six months and average milk yield per cow per day was about 1.37 liters. In Ethiopia, dairy production is mainly of subsistent type largely based on indigenous breeds of cattle. This shows that intensification and commercialization of smallholder farm households used to improve the dairy production and the living standard of smallholder farmers. Intensification of smallholder dairy production typically involves the adoption of a combination of cattle breeds with increased genetic potential for milk production and other complementary inputs.

The country has set-up the second five year growth and transformation plan (GTP) with a vision of building an economy which has a modern and productive agricultural sector with enhanced technology. One of the strategic pillars of the plan is maintaining agriculture as a major source of economic growth. The key strategy designed to achieve this is scaling-up of the best technologies and practices of the model farmers for use by all other farmers. Governmental, non-governmental, private and international organizations have been engaged in promoting and disseminating dairy production technologies to smallholder farmers through various channels of extension such as technology verification and demonstrations, knowledge and skill enhancing training, experience sharing visits, farmer-to-farmer information exchange mechanisms and others. Improved dairy breed technologies, improved feeds and feeding practices, dairy processing technologies and improved health management practices are technologies diffused (Samuel *et.al*, 2016).

Even though large efforts have been made to disseminate dairy technologies through the support of governmental and non-governmental organizations in different parts of the country, the adoption of dairy technologies by farm households varies widely across different agro-ecologies and within the same agro-ecology based on various technical and non-technical determinant factors (Dehinenet *et.al*, 2014). Moreover, the impacts of the technologies on the farmers' livelihoods which can be used as an instrument for policy formulation in the dairy sector (breeding, marketing, health and other segments of the sector) have not been reviewed earlier and well- documented. Therefore, it is an effort to review the aspect thoroughly and bring minor details into focus to have better understanding of the rate and extent of adoption, impacts and determinant factors of dairy

technologies.

2. Definition and Concept of Technology Adoption

New agricultural technology is generally a bundle or package of different technological elements such as improved production and productivity; plus the technical practices and skills needed for their effective use. Any definition of technology encompasses a wide range of phenomena. In the broadest sense, technology is defined as the translation of scientific laws into machines, tools, mechanical devices, instruments, innovation, procedures and techniques to accomplish tangible ends, attain specific needs, or manipulate the environment for practical purposes (Shahin, 2004).

Adoption is a mental process through which an individual passes from hearing about an innovation to its adoption that follows awareness, interest, evaluation, trial, and adoption stages (Bahadur and Siegfried, 2004 cited by Samuel *et al*.,2016). Adoption of any agricultural innovation can be measured in two ways: in terms of the number of farmers who adopt the innovation and in terms of the total area on which the innovation is adopted. Neither of measures is inherently better and the choice depends on the issue being addressed. If the goal is to determine how many people have been affected by an innovation, it makes sense to ask what proportions of farmers have adopted the innovation. However, if the goal is to calculate the economic benefits attributable to adoption, it makes sense to ask how much area is affected (Morris *et al.,* 2001).

3. Determinants of Adoption of Dairy Technologies

Introduction of new technology to smallholder farmers by itself does not guarantee for a widespread adoption and efficient use of technologies. Adoption decisions of farmers are influenced by different factors. Factors associated with economic, institutional, demographic and physical characteristics can influence farmers' decisions on adoption of agricultural innovations. Past studies have documented some demographic and socioeconomic factors that influenced the adoption of different technologies among smallholder farmers in developing countries. Studies by Croppenstedt *et.al* (1996) in Ethiopia and Naseem (1995) in sub- Saharan Africa identified plot size, previous experience with fertilizer, supply of fertilizer, farm size, amount of rainfall, household size, and the ratio of price of main crop to cost of fertilizer as well as accessed to credit as factors constraining fertilizer demand among arable crop farmers. Feder *et al.* (1985) in their research report stated that credit, farm size, risk, labor availability, and human capital, land tenure and education are main factors affecting technological adoption. For ease of grouping, the variables identified as having relationship with adoption are categorized as household personal, economic factors, institutional factors, and intervening (psychological) factors (Wongelu, 2014).

3.1. Personal Factor

Age is an important household characteristic influencing the adoption behavior of subsistence farmers. Kaaya *et al*., (2005) used Tobit model to reveal factors influences the extent of adoption of artificial insemination (AI) services and found age of the farmer was positively associated with adoption and use of AI technology. However, in contrary to this, the findings reported by Quddus (2013) and Dehinenet *et.al.* (2014) stated that the probability of adoption decreased with the increase of age of household heads. Young household heads are more likely to apply new technologies because younger household heads are less risk averse than older counterparts (Howley *et al*., 2012).

As dairying was/is labor intensive: dairy production, in general and marketable surplus of dairy products in particular, is a function of labor. Accordingly, household with more family members tended to have more labor and to adopt dairy technology than household with less family members which in turn increased milk production and then milk market participation of the households (Dehinenet *et al*., 2014). In addition, Workneh (2011) and Howley *et al*. (2012) also affirmed that farmers with large family size might significantly adopt the technology, to satisfy the need of their family; this justifies that dairy technology needs more labor, hence having more family size could alleviate labor scarcity that constitute one of the limitations for technology uptake.

Education level is expected to have a positive influence on adoption of dairy technologies because of there is a strong link between education and knowledge and the ability to read technical materials. Education status and experiences of the dairy farmers on dairy farming and participation of the dairy farmers in various dairy farming related organizations also had positive and significant relationship with the adoption of the improved dairy husbandry practices (Lemma *et al*., 2012). Dehinenet *et .al*. (2014) also revealed that the probability of dairy technology adoption and level of use increased with the increase of farmer`s farming experience. Practices and experiences lead the farmers to have a better know how to handle technologies and understand their benefits easily.

Training on improved livestock technologies creates its awareness and is expected to affect its adoption positively (Kaaya *et al*., 2005; Lemma *et al*., 2012; Quddus, 2013; and Dehinenet *et al*., 2014.

3.2. Economic Factor

Larger land holdings are associated with greater wealth and increased availability of capital. Farmers with larger land holdings are more likely to invest in technologies that increase agricultural productivity and income (Jayne *et al*., 2010). For example, farmers with larger farm size could allocate part of their land for intensive fodder production (Staal *et al*., 2002).

Livestock holding is an important indicator of household's wealth position. Livestock are also an important income sources which enables farmers to invest on adoption of improved agricultural technologies. It influences the adoption of improved technologies differently by different people across different areas. In most cases, it has positive contribution to household's adoption of agricultural technologies (Wangelu, 2014). Many adoption studies reported positive effect of livestock holding on adoption (Kidane, 2001; Taha, 2007; Gidey and Mekonen, 2010).

The high population to land ratio results in scarcity of land and diminished grazing land, unable to maintain large number of livestock holdings. As a result, farmers are expected to reduce the number of low yielding animals and keep few productive animals suitable for production of marketable outputs such as milk (Medola, 2007). Therefore, adoption of improved dairy cow technologies is expected to be negatively associated with large size of livestock ownership (Upton, 2004).

3.3. Institutional Factor

3.3.1. Access to Credit services

Many farmers have difficulty accessing credit and face high interest rates, which prevents investment in profitable technologies (Abdulai and Huffman, 2005). Availability of crossbred cows and accessibility of saving institutions were positively associated with farmer`s likelihood to adopt dairy technology and level of adoption. As the technology is available in the areas the probability of adopting the technology increases. This is because it reduces the transport cost and farmers may learn more about the technology by observing which initiate them to adopt (Dehinenet *et al*., 2014). Having access to formal (bank and microfinance) and informal (*Iquib*) saving institutions create a good opportunity for farmers to have an asset and to purchase different agricultural technologies including cross breed cows (Sisay *et al.,* 2013). The finding of Muzari *et al.* (2012) also stated that the major option for increased adoption of technology is to overcome the income/ capital constraint through increased credit provision. This is consistent with the report of Akudugu *et al.* (2012) and Obayelu (2017).

3.3.2. Access to Information

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 (Karki, 2004). 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 non-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 (Obayelu, 2017). It is, therefore, important to ensure the information is reliable, consistent and accurate.

3.3.3. Access to Extension Services

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 (Kuuma, 2005).

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.* (2011); Adoption of improved maize and land management in Uganda by Kuuma (2005); adoption of modern agricultural technologies in Ghana (Akudugu, 2012) 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 (Kuuma, 2005).

3.3.4. Access to Social Network

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*. (2011) 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 (2010) 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.

4. Impact of dairy technologies

The impact of specific improved technologies on the livelihood of the farmer is measured in different indicators. Few of those indicators are impact on income and income diversity of the farmers, cash needs of the family, asset availability, new house construction and rehabilitation of the old, school fees and purchase of educational material of children, medical fees, clothing fees, seed purchase and purchase of livestock and crop for the family size. On other hands, household food diversity and food availability are the criterion for the nutritional effects of adoption (Samuel *et al*., 2016).

4.1. Sources of household Income

In developing countries, livestock production is a major source of income. For many mixed, smallholder farming systems, livestock is an important source of income (Sansoucy *et al*., 1995). Similarly, Mohammed *et al*. (2004) reported that the significant raise in the household income of smallholder dairy farmers in the rural Ethiopia is due to the adoption of market-oriented dairy production using crossbred cows and improved dairy technologies.

4.2. Milk Consumption

Intensification of dairy production through the use of agricultural technologies is widely advocated in developing countries, both to meet increasing demand for milk products and to contribute to the development of households. Consumption of dairy products usually has a positive effect on human nutrition and health (Rehman *et al.,* 2007).

The consumption of milk improve household nutrition as quality foods of animal origin enhance human growth and development, particularly of children in chronically mild to moderately malnourished populations, because they contain amino acids absent in cereals and essential to human health (Sansoucy *et al*., 1995). Dairying with crossbred cows and improved production technologies could have a positive impact on human nutrition, both directly by consumption of increased milk and dairy products and, indirectly via sale of increased output and the purchase of more and better quality food (Tangka *et al.,* 2002).

4.3. Household health

It has been well established by nutritionists that consumption of more dairy products results in a better human nutrition and health (Neumann *et al*., 1993). So, the family member of the households who consume more dairy products is healthier. Households that used market-oriented dairy production technologies increased their income and animal values significantly. The increased resources led to significantly higher food consumption, calorie intake and marketed surplus. The significantly increased marketed surplus has also the potential to improve diets of non-dairy households (Tangka *et al.,* 2002).

4.4. Education

As a result of the higher income from improved dairying, the household could spend more on household items and educating their kids (Samuel *et.al*, 2016).

5. Conclusion and Recommendations

The adoption of dairy technologies has significant impacts on livelihood indicators such as household income, nutrition, food security, health care and access to education. This implies that introducing and disseminating appropriate dairy technologies to smallholder farmers with a continuous follow up could be a means through which their livelihoods can be improved and it enables to narrow the milk demand – supply gap in both rural, peri urban and urban consumers which has a good public health implication at the nation wise. Therefore, based on the above conclusions the following recommendations are forwarded:

- ♣ Introducing different dairy technologies should be supported with a continuous training or technical backup on how to manage and utilize the technology as well.
- ♣ Even though cross breed cows give a better milk yield per day, still both breeds (local and cross breeds) provide less than their potential. Therefore, different actors should work collaboratively to increase the productivity and production of the dairy sector.
- ♣ Dairy technology input and/or service providers should undertake follow ups to identify possible problems and/or evaluate the use and benefits of the interventions
- ♣ 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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