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A Review of Factors Influencing Adoption of Rainwater Harvesting Technology in Ethiopia

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Abstract
Ethiopia is characterized by erratic nature of rainfall and dry spells during crop growing season. Hence, rainwater harvesting technology should support rain-fed farming in order to alleviate the moisture stress during critical crop growing season. Rainwater harvesting is a method of collecting, storing and conserving surface runoff for agricultural production and domestic uses. Although rainwater harvesting technology was introduced in Ethiopia before a decade, its adoption rate by smallholder farmers was very small. This is due to lack of farmers' participation during the introduction of technology and presence of factors influencing the adoption of rainwater harvesting technology in Ethiopia. In this paper, major factors determining the adoption of rainwater harvesting technology in Ethiopia were reviewed. Adoption of rainwater harvesting technology in Ethiopia was determined by factors like capital ownership, household characteristics, off-farm activity, access to markets, extension, credit and inputs, social capital, and biophysical characteristics. Therefore, rainwater harvesting technology should be transferred in the country with farmer participatory approach. Furthermore, researches need to be conducted in order to widen the water harvesting technology options.
Keywords: Rainwater, harvesting, technology, adoption, review, factors: Ethiopia

1. Introduction

Rainfall is the major source of agricultural water supply for most of the subsistence farming system in Sub-Saharan Africa. However, its distribution is unreliable particularly for the semi arid and dry sub humid areas that crop production as well as animal rearing has become risky enterprise and the lives of the people extremely precarious. National governments and international organizations have been picking up one and throwing another approach to ensure the reliability of the availability of water for agriculture (Aziz Shikur and Tesfaye Beshah, 2013).
Zemadim et al. (2011) indicated that there are successful situations of rain water management programs as part of sustainable land management to increase in-situ water availability and increase aquifer recharge in the Blue Nile River Basin. On the other hand, despite massive investments in ponds, the adoption rate is minimal and possibly due to its low rate of success.

As stated by Kurukulasuriya and Rosenthal (2003), the use of rainwater management interventions, including soil and water conservation (SWC) techniques, is widely accepted as a key strategy to improve agricultural productivity by alleviating growing water shortages, the effects of droughts and worsening soil conditions. In the rainfed agroecological landscapes of Ethiopia, the low yield is typically not due to the lack of water but rather a result of the inefficient management of water, soils and crops (Amede 2012).

According to Awulachew et al. (2012), it has been demonstrated that access to rain water management interventions can reduce poverty levels by approximately 22%. These interventions can also provide a buffer against production risks associated with increasing rainfall variability due to climate change (Kato et al. 2009). While various studies have highlighted the potential of rain water management interventions to increase agricultural productivity and improve livelihoods in Ethiopia (Pender and Gebremedhin 2007; Kassie et al. 2008; Awulachew et al. 2010), in practice adoption rates of these interventions remain low (Santini et al. 2011).

2. Factors Influencing Adoption of Rainwater Harvesting Technology

2.1. Biophysical Characteristics

According to Kassie et al. (2010), various rainwater management technologies can be used as a coping mechanism in areas with low rainfall and moisture stress, while others are more suited to areas with high rainfall. Unfavorable rainfall amounts, such as too little rainfall, may encourage farmers to adopt soil and water conservation practices. On the other hand, the high rainfall intensities that result in high runoff can augment soil erosion leading to nutrient depletion. It can also increase water logging which may negatively influence the likelihood of adoption of soil and water conservation practices.

Gebregziabher et al. (2013) stated that farm households may adopt certain rainwater management technologies to reduce exposure to rainfall hazards by increasing soil moisture, reducing soil loss from erosion and flooding, and diversifying cropping patterns.

According to Aziz Shikur and Tesfaye Beshah (2013), the steepness or flatness of a plot affects the use of rainwater harvesting technologies. The inference from their result is that those users of rainwater harvesting technology with plain (flat) slope have more ease to use rainwater harvesting technologies than farmers having steep land slope. Ngigi (2003) also stated that the nature of the slope largely determines the suitability of the run off generation.

Majority of rainwater harvesting technology adopters prefer sandy soil to construct underground rainwater harvesting technology as it can be easily ruptured with respect to clay and loam soil. In a similar manner, the amount of cost of labor and time required to rupture sandy soil is relatively lower than clay and loam soil. This is an indication that farmers with sandy soil have more ease to adopt rainwater harvesting technology (Aziz Shikur and Tesfaye Beshah, 2013).

2.2. Capital Ownership

According to Gebregziabher et al. (2013), capital ownership is captured by the number of livestock, farm size per adult equivalent (a dummy variable that captures whether or not a farm household owns the land) and the value of durable household assets. The assumption is that households that own more capital are wealthier and more likely to take risks associated with the adoption of new technologies. Moreover, such households are less constrained financially and are able to purchase inputs. Household expenditure is also considered as a proxy for income level. Buyinza and Wambede (2008) reported that farmers' who had bigger farms were more likely to adopt rainwater harvesting techniques.

Gebregziabher et al. (2013) also stated that the expected effect of capital on the adoption of rainwater management technologies is positive. However, since households with relatively large landholdings may be able to diversify their crops and income sources, they may be less susceptible to risks and shocks; as such, they may be less interested in investing in rainwater management technologies as a coping mechanism.

Aziz Shikur and Tesfaye Beshah (2013) stated that adopters of rainwater harvesting technology own more livestock units, have a relatively large farm size, have relatively large adult equivalent labor force, have better farm income, have better access to credit and agricultural extension service, a relatively large area for pepper production and most of them involved in off-farm activities in the past cropping season. It has also found that farmers' income level was an important factor affecting adoption of rainwater harvesting techniques (He *et al.,* 2007).

2.3. Household Characteristics

In this regard, we considered different household characteristics and family member composition as a proxy for the human capital of the households. The level of education, age and gender of the family members, and family size are important indicators of the available human capital, which has an influence on the adoption of technologies. Households with more educated members are likely to have better access to information, and are more aware about the merits and demerits of the technologies. They are also able to interpret new information to make knowledge-based decisions in favor of appropriate/suitable technologies. On the other hand, households with more educated members may be less likely to invest in labor-intensive technologies and practices, because they are more likely to earn higher returns from their labor and capital investment through other activities (Kassie et al. 2012; Pender and Gebremedhin 2007).

Aziz Shikur and Tesfaye Beshah (2013) stated that sex and education level of the household head, were significantly related to adoption of rainwater harvesting technology indicating that being male headed and having a better educational status positively correlated with adoption of the same.

Hatibu (2003) noted that farmers with a higher level of education were likely to adopt water harvesting systems earlier, therefore shortening the adoption of the techniques. In most adoption studies, farmers with higher levels of education attainment are more likely to adopt or to practice rainwater harvesting techniques compared to less educated farmers (Chianu and Tsujii, 2005).

Gebregziabher et al. (2013) stated that the age of the members of the household may imply farming experience and the ability to respond to unforeseen events/shocks. Older household heads may have an accumulation of capital and respect in their community, implying greater social capital. On the other hand, age can be associated with loss of energy and short planning horizons, and the reluctance towards new technologies due to risk aversion behavior.

Ndiritu et al. (2011) stated that in sub-Saharan Africa, there are gender-specific constraints that women face, such as less education, inadequate access to land, and production assets and livestock ownership. These constraints will clearly have a direct effect on technology adoption including rainwater management technologies, where women are usually less likely to adopt these technologies as they are resource-demanding and labor-intensive.

2.4. Off-Farm Activity

Economic incentives play an important role in the adoption of rainwater management technologies. Households' access to off-farm employment and alternative sources of income are likely to influence the adoption of rainwater management technologies in different ways. For example, those who have alternative sources of income are better able to adopt and invest in these technologies. On the other hand, participation in off-farm income-generating activities is likely to divert labor from on-farm activities and working on rainwater management technologies, both as a private investment and as collective action (Gebregziabher et al., 2013)

The finding of Deressa et al. (2009) revealed that off-farm activity is captured by the participation of household members in the Food For Work program and/ or whether any member of a household had migrated.

2.5. Access to Markets, Extension, Credit and Inputs

According to Gebregziabher et al. (2013), the walking distance was used as a proxy of access to markets, extension and input supply centers. Access to credit was captured by the household response when asked whether they had requested for credit and the actual amount of the loan they received in the previous year. Access to markets can influence the use of various inputs as well as access to information and support services.

There is positive association of market distance with adoption of rainwater harvesting technology. This indicates that market distance from dwelling may matter on rainwater harvesting technology adoption (Aziz Shikur and Tesfaye Beshah, 2013; Molla, 2005).

Deressa et al. (2009) revealed that access to credit has a significant positive impact on the likelihood of using soil conservation techniques, changing planting dates and using irrigation in the Blue Nile River Basin. Therefore, the hypothesis is that the longer the walking distance to markets and other service centers, the less likely it is that households will adopt a particular rainwater harvesting technology.

According to Aziz Shikur and Tesfaye Beshah (2013), farmers' adoption of new innovations is influenced among other things by access to information. The result showed that there is significant association between having extension service on rainwater harvesting practice and the adoption of rainwater harvesting technology. Melaku (2005) in his study also concluded positive and significant association of extension service and adoption of rain water harvesting technology.

2.6. Social Capital

In Ethiopia, it is common for rural communities to form informal groups for labor sharing, and saving and risk-sharing mechanisms. This can take place in the form of friendship or kinship networks, implying that households with a large number of relatives and wider networks are likely to be more resilient to risk and have fewer credit constraints; they are more likely to adopt technologies because they are in a better position to take risks (Fafchamps and Gubert 2007).

With limited information and imperfect markets, social networks can facilitate the exchange of information, enabling farmers to access inputs and overcome credit constraints. Social networks also reduce transaction costs and increase farmers' bargaining power, helping them to earn higher returns when marketing their products, which in turn can affect technology adoption (Lee 2005; Pender and Gebremedhin 2007; Wollni et al. 2010).

Kassie et al. (2012) stated that, farmers who have limited contacts with extension agents can be informed about the methods and benefits of new technologies from their networks, as they share information and learn from each other. On the other hand, having more relatives may reduce incentives for hard work and induce inefficiency, such that farmers may exert less effort to invest in technologies.

3. Conclusion

Rapid population growth, rainfall variability and land degradation are the major challenges for attaining food security in Ethiopia. Rain water harvesting plays a significant role in achieving food security in Ethiopia since it supports the rain-fed farming system which relies on the erratic nature of the country's rainfall. In this paper, several factors which determine the adoption of rain water harvesting technology in Ethiopia were reviewed. These factors include age, sex, family, education level, capital ownership, income level, off-farm activity, access to markets, extension, credit and inputs, and biophysical characteristics. These factors significantly affect the adoption rate of rainwater harvesting technology in Ethiopia. Therefore, rainwater harvesting technology should be transferred in the country by participating farmers. Furthermore, researches need to be conducted in order to widen the water harvesting technology options and to narrow the knowledge gaps of farmers on rainwater harvesting technology.

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