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Factors Affecting Adoption of Agroforestry and Evergreen Agriculture in Southern Africa

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Abstract

This paper examines the factors that affect adoption of agroforestry and integrated soil fertility management (ISFM) practices in Southern Africa. Agroforestry practices, especially evergreen agriculture and conservation agriculture with trees have emerged as sustainable measures of addressing land degradation and loss of soil fertility. Although agroforestry is known to be beneficial to farmers and the environment, its adoption rate falls far behind the projected goals. The present study reviewed several publications on adoption of agroforestry in Southern Africa and complemented the review with household and key informant interviews to obtain evidence from farmers and promoters of the technologies on the factors affecting adoption. The study revealed that the major factors affecting adoption of agroforestry fall into two main categories of socioeconomic and biophysical factors. The factors are high initial costs of agroforestry practices (75%), low extension knowledge (69%); unavailability of agroforestry germplasm (69%) for economic, social and biophysical categories respectively. Up to 84% of the key informants indicated that awareness of the connection between agroforestry and land quality improvement could lead to wide scale adoption of the technology. We conclude that Government policies will strongly influence adoption of agroforestry technologies. There is need to institutionalise sustainable agricultural land management practices through policy formulation, budgetary allocation for extension officers and farmer training and starter up inputs. Promotion of agroforestry should be coupled with investment in awareness creation, farmer-centered approaches in selection of technology and provision of inputs in the initial stages. Strong collaboration among policy makers, researchers and extension providers will be required to harmonise messages to be delivered to farming communities.

Keywords: adoption, agroforestry, conservation agriculture, land degradation, soil fertility

1. Introduction

Most countries in Southern Africa largely depend on agriculture in order to achieve economic growth. Agricultural activities provide about 70-80% of employment and 40% of Africa's export earnings (FAO, 2006). It follows therefore that a well-performing agricultural sector is fundamental in addressing hunger, poverty and inequality through the attainment of the Millennium Development Goals (MDGs) by 2015. In Southern Africa the economic challenges are exacerbated by the rapidly increasing population and the increased demand for food that has resulted in tremendous amount of pressure on the land base (NEPAD, 2003; Kwesiga, 1999). Many smallholder farmers are in a state of poverty and cannot afford industrial inputs to improve yields (Thangata et al., 2007). The problem of food insecurity and poverty in Southern Africa is thus compounded by pronounced environmental degradation and loss of valuable natural assets such as forests. The degradation of land and loss of soil fertility is caused by the breakdown of the traditional production system and low adoption of strategies for managing natural resources (Kwesiga et al., 1999). The need to improve soil fertility has become a very important issue in development policy.

Agroforestry and conservation agriculture have emerged as a sustainable land management practices addressing land degradation and loss of soil fertility (Lehmann et al., 1998; FAO/REOSA, 2010). Agroforestry is a farming system that integrates crops and livestock with trees and shrubs. A positive development is that agroforestry technologies have increasingly become available to more and more smallholder farmers in Southern Africa (Mafongoya, 2000; Kwesiga et al., 2003). Three of the most promising low cost agroforestry practices for soil fertility replenishment are the use of improved tree fallows, relay cropping and mixed inter- cropping (Ajayi & Catacutun, 2012; Ajayi et al., 2008). Besides improving soil fertility and land quality, agroforestry systems help to suppress weeds, enhance the hydrological cycle, and increase the amount of carbon in the soil. Agroforestry ensure provision of non-timber products such as fruits, fodder, energy and fibre. In order to gain from the advantages of agroforetry and conservation agriculture, the two are combined in what is referred to as Conservation Agriculture with trees (CAWT) (Mutua et al., 2014). Conservation Agriculture with trees is practiced in Malawi, Mozambique and Zambia to further boost soil performance. In this, soil cover can be from living crop such as Mucuna pruriens, pigeon peas and peas.

The experiences of farmers with agroforestry and conservation agriculture with trees led to the evolution of the concept of *Evergreen Agriculture,* one of several types of agroforestry in which more intensive farming integrates trees into crop and livestock production systems at various scales - field, farm and landscape. Even though agroforestry brings forth several benefits to farmers it has received mixed reactions from farming communities in Southern Africa. Adoption rates for agroforestry practices have not been as fast as desired (Clarke & Matose, 1992; Sibanda, 1992; Chirwa, 2000; Makaya, 2000). We define adoption as a decision to make full use of an agroforestry technology or Evergreen Agriculture as the best course of action (Rogers, 2003). Literature review shows that both biophysical and socio-economic statues of the farmers have played a role in the levels of adoption. Input and output uncertainties (regarding the costs of technology use and added benefits) are forms of risk that farmers face when deciding whether or not to adopt new technologies. Earlier studies (Binswanger, 1980; Antle, 1987) reported that farmers in developing countries are risk averse and therefore tend to delay the decision to adopt new technologies. A clear understanding of the influential factors in farmer decision-making regarding adoption of agroforestry and evergreen agriculture is crucial in improving land management practices for sustainable livelihoods. This study was initiated with the aim of establishing the challenges for adoption of agroforestry in Southern Africa.

2. Methodology

The study assessed adoption of agroforestry in selected countries in Southern Africa from August to December, 2014. The region falls within the Zambezian ecoregion with mostly *miombo* woodlands dominated by *Brachystegia, Julbernardia* and *Isoberlinia* species. The *miombo* woodlands characterize the upland plateau ecoregion of Southern Africa, found within an altitude ranging from 600 –1200 metres and have a mean annual rainfall ranging from 800 –1400 mm. The major staple food crop for the region is maize. Several agroforestry trees species such as *Faidherbia albida, Leucaena leucocephala, Sesbania sesbania, Tephrosia vogelli, Senna spectabilis, Cajanus cajan* are being promoted for improving soil fertility. The study assessed experiences in Malawi, Mozambique, Zambia and Zimbabwe.

2.1 Data Sources

2.1.1 Primary Data

Primary data were obtained through formal interviews where a checklist was administered to key informants from organizations promoting agroforestry technologies. A total of 58 Non governmental organizations and government departments were identified. Organizations that had implemented agroforestry practices for more than eight years were targeted. Of the sampled 58 key informants, fourty five responded to the checklist through discussions held at their offices while five of them responded through emails and eight did not respond making a total of 50 key informants who provided responses. The checklist for key informants sought data such as length of time when stakeholder has been promoting agroforestry, technologies promoted, factors promoting and reducing adoption of technologies, incentives encouraging adoption among others. The other primary data was obtained from a household survey conducted with 120 smallholder farmers from three districts of Mzimba, Northern Malawi, Ntcheu in Central Malawi and Zomba in Southern Malawi. In Mzimba households were sampled from Champhira Extension Planning Area (EPA) with average household size of 6 and farm size of 3.2 ha.Champhira has 13,450 farm families and the farmers grow tobacco, maize, potatoes, tomato, beans and vegetables. In Ntcheu households came from Manjawira EPA with 20,279 farm families with an average of 0.6 ha per households and farmers mostly grow maize, beans.

In Zomba the survey was conducted in Malosa EPA with a total of 20,018 farm families and an average land holding size of 0.4 hectares and mostly growing maize, cassava, sweet potatoes, tobacco, pigeon peas and ground nuts. The sample composed of 44% (n = 53) males and 56% (n = 67) females. The three districts were selected as they have had agroforestry interventions for the past 20 years implemented by government, NGOs including the International Centre for Research in Agroforestry and Concern Universal. The data from structured questionnaire included age of the household head, family size, household income, residential status of household, education level of household head, crops grown, land size, frequency of extension contact, awareness of agroforestry, agroforestry technology practiced, benefits of agroforestry and challenges among others.

2.1.2 Secondary Data

The secondary data collection adopted a method used by Muhumuza and Balkwill (2013). Data was obtained through a review of literature on the challenges and opportunities for adoption of agroforestry, conservation agriculture and evergreen agriculture. The literature reviewed was systematically selected from the internet mostly Access to Global Online Research in Agriculture (AGORA) supported by the Food and Agriculture Organization. Other search tools for full articles included use of Google and Google Scholar. Web searches were conducted from August 2014 and December 2014. The search terms used separately or in combination included: *"Agroforestry southern Africa", "Agroforestry challenges southern Africa", "barriers to agroforestry adoption" "Conservation agriculture adoption", "Conservation Agriculture Southern Africa, "smallholder farmers conservation agriculture", "evergreen agriculture adoption", "integrated soil fertility management Africa" and "land productivity southern Africa".* The web search resulted in 172 journal articles, books, technical papers, working documents, and theses which are collectively called "publications" in this paper. Of the 172 publications, 57 met the criteria for selection and inclusion. A publication was selected for review if it met the following criteria:

1) when it appeared in a peer reviewed journal, conference proceedings, project reports and theses.
2) reported major challenges to adoption of agroforestry, conservation agriculture and evergreen agriculture in southern Africa
3) Reported on opportunities and lessons learnt from case studies or project implementation experiences on agroforestry, conservation agriculture and evergreen agriculture in southern Africa.

2.2 Data Analysis

The procedure of reviewing the publications followed guidelines recommended by Randolph (2009). Deductive coding of text as explained by Fereday and Muir-Cochrane (2006) was conducted on each of the selected publications. A factor was considered "positively contributing to adoption" if the publication reviewed stated that the presence of the factor contributed to adoption. If an approach such as the inclusion of chemical fertilizers in Government-sponsored Farm Input Subsidy Programme (FISP) improved yield of annual crops by farmers but discouraged adoption of integrated land management technologies, it was categorized as "factor responsible only for failure of adoption". Data from household questionnaire was analyzed using Statistical Package for Social Scientists (SPSS) version 17.0 and descriptive statistics that included the use of frequency distributions and percentages was used. Calculation of the percentage was used as a tool of analysis for interpreting of the qualitative information gathered from respondents. Data collected from key informant interviews was compiled into similar thematic areas in the field and summarized into percentages.

3. Results

3.1 Agroforestry Technologies Adopted by Small Holder Farmers

Results of the farmers household survey with an average land size of 0.4 ha shows that among available technologies mixed intercropping (33.7%) and retention of trees on farmland (25%) have relatively higher rates of adoption (Figure 1) than improved fallow and biomass transfer.

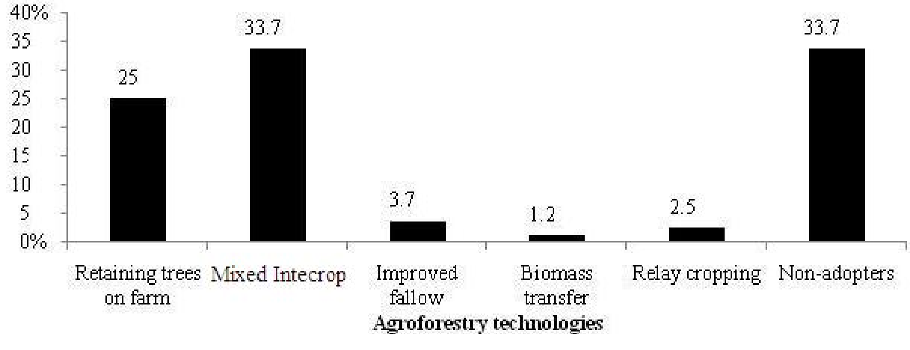

Figure 1. Adoption of different agroforestry technologies by households

3.2 Factors Affecting Adoption of Agroforestry

Interviews from key informants and households' interviews and review of publications on adoption of agroforestry and evergreen agriculture all point to two major categories of factors affecting adoption namely socio-economic and biophysical (Franzel et al., 2001). Data from review shows that there were 7 biophysical aspects that had an influence on the level of adoption of the agroforestry as compared to 15 socio-economic factors. About 30% (16) of the key informants attributed low adoption to biophysical factors while 26% (n = 32) of households indicated that biophysical factors are responsible for low adoption. The reviewed publications showed 38.4% attributing low adoption to biophysical while 58.7% suggested that socioeconomic challenges were responsible for low adoption while 70% of households implied that socioeconomic factors were responsible for low adoption of technologies.

Age of farmers adopting agroforestry is considered an important aspect and this study has shown that most adopters are those within the age intervals of 31 to 40 years followed by 20 to 30. This age group range of 20 to 40 years contributes 47% of total adopters of the technology. However, the overall results show that there are no significant variations in adoption ratios of the technology among other age groups thus those farmers within 41 to 50 years contributed 17.5% likewise those within 51 to 60 years had 17.5%, those within age group of 61 to 70 and greater than 70 years contributed to 14.5% and 3.5% respectively.

Other equally important factors identified by respondents as affecting adoption of agroforestry included high expenses related to inputs as indicated by 31% of the respondents while 22% indicated lack of knowledge and skills in agroforestry and this was complemented by the indication that there is inadequate extension support (Figure 3).

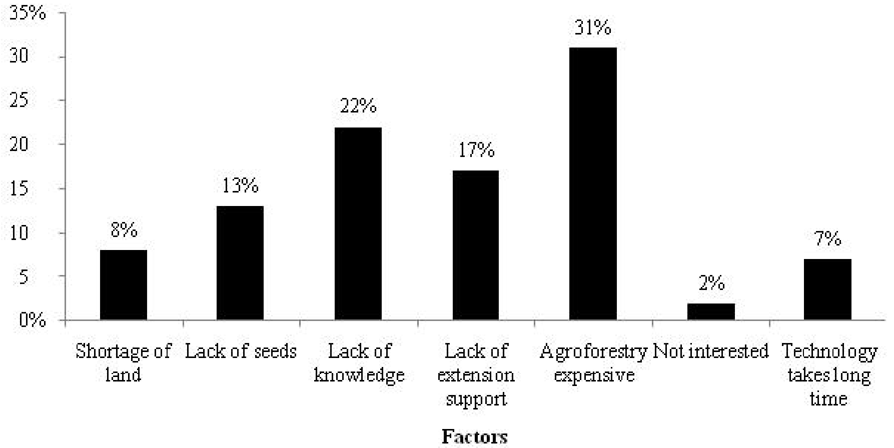

Figure 2. Factors affecting adoption of agroforestry technologies

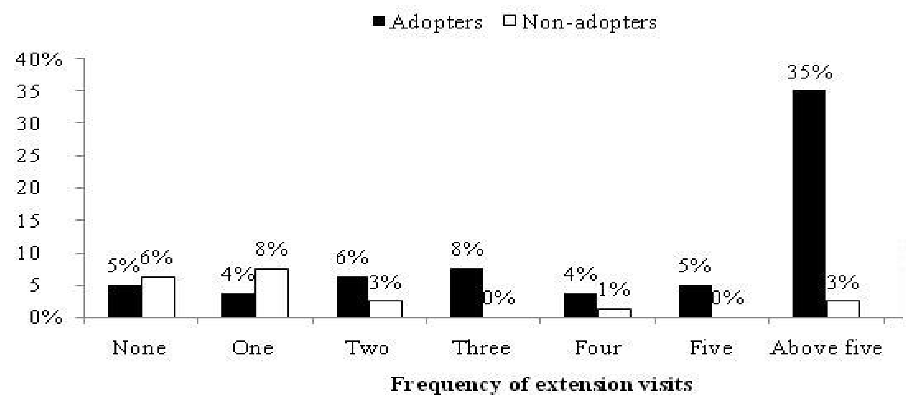

Figure 3. Adoption of agroforestry technologies as affected by frequency of extension

3.3 Responses from Key Informants on Factors Affecting Adoption of Agroforestry

Complementing the household survey results were findings from key informants where low extension capacity contributed to the low adoption as indicated by 69.4% while 16.7% of the key informants perceived the capacity of extension to be strong. However, some key informants were of the opinion that understanding of relationship between climate change and land degradation (86.1%), participation in the tobacco industry (75.0%), early rewards from some multipurpose tree species (63.9 %) can substantially contribute to increased adoption rate (Table 1).

Table 1. Enabling factors for adoption of agroforestry technologies

Factors promoting adoption	(%) for adoption
Understanding of relationship between climate change and land degradation	31 (86.1%)
Early rewards from multipurpose tree species	27 (75.0%)
Participation of tobacco industry in reforestation and agroforestry	23 (63.9%)
Cash transfer as an incentive in agroforestry adoption	9 (25.0%)

In addition, information from key informants strongly support the findings from household surveys on aspects relating to: high initial cost of labour and herbicides (75.0%), poor understanding of integrated soil management practices (55.6%), limited land availability (47.2%), participation of different stakeholders providing conflicting extension messages (52.8%), and absence of a guiding policy (33.3%) (Table 2). However, 33% of the key informants indicated that existence of several stakeholders in agroforestry promotes the extent of adoption

Table 2. Barriers of adoption of agroforestry technologies reported by key informants

Barrier to adoption of agroforestry	%) for failure to adopt
High initial costs for agroforestry including herbicide, labour	27 (75.0%)
Low extension capacity and extension materials for training of farmers	25 (69.4%)
Available seed is much lower than the demand by farmers	25 (69.4%)
Stakeholders providing conflicting extension messages	19 (52.8%)
Poor understanding of tree management among extension staff	20 (55.6%)
Limited available land for some agroforestry practices	17 (47.2%)
Poor understanding of appropriate ISFM practices among farmers	17 (47.2%)
Cash transfer as an incentive in agroforestry adoption	17 (47.2%)
Absence of a guiding policy on agroforestry	12 (33.3%)

3.4 Revelations from Selected Publications on Factors Promoting Adoption of Agroforestry

Previous studies reviewed have shown that farmers' participation in agroforestry practices and evergreen agriculture has been positively correlated with adoption (Table 3). About 66.7% of the reviewed publications found that indigenous agroforestry practices that promote the retention of soil fertility improving tree species such as *Faidherbia albida* in farmer maize fields and those that promote use of multipurpose trees has improved the level of adoption of agroforestry practices (Table 3).

Table 3. Factors promoting the adoption of agroforestry and conservation agriculture with trees

Promoter to wide scale adoption agroforestry and evergreen agriculture	No. and % of publications reporting the factor
Farmers' participation in defining the appropriate technology	79 (90.8%)
Ease and speed of eliminating weeds through herbicides	19 (21.8%)
Presence of multipurpose tree species	58 (66.7%)
Existence of indigenous agroforestry practices e.g. *Faidherbia Albida* in maize fields	41 (47.1%)
Clear evidence of crop resilience especially during drought episodes	27 (31.0%)
Pressure to the tobacco industry to participate in tree planting	10 (11.5%)

3.5 Factors Hindering Adoption of Agroforestry as Revealed in Selected Publications

In total, 69.0% of the reviewed publications show that most farmers in Southern Africa have small land size which poses a challenge to adoption of some recommended agroforestry practices. Apart from land size, tenure also emerged as an important factor in adoption of agroforestry as evidenced by up to 50.6% of the publications that indicated that some agroforestry practices are difficult to adopt under communal land ownership (Table 4). Therefore high initial costs of agroforestry, small land size, lack of capacity by extension officers to train farmers, high illiteracy rate among the small holder farmers, insecure land tenure and low access to seed are among the factors contributing to low adoption of agroforestry technologies. On the other hand, competing uses for crop residues is the most important factor that determines adoption of conservation agriculture (Table 4).

Table 4. Barriers to adoption of agroforestry and conservation agricultural technologies

Barrier to adoption of agroforestry technology	No. and % of publications reporting the factor
Agroforestry and conservation agriculture have high initial labour requirements	73 (83.9%)
Crop residues for maize have various competing uses	70 (80.5%)
There is high costs of input (fertilizer, herbicides)	65 (74.7%)
Small land size	60 (69.0%)
Lack of extension capacity to train farmers in tree management	51 (58.6%)
Communal ownership of land in villages	44 (50.6%)
High illiteracy levels among farmers to comprehend practices	39 (44.8%)
Poor access to appropriate tree seeds and seedlings	36 (41.4%)
Female headed households	34 (39.1%)
Rapid declining of soil fertility making cultivation of trees is difficult	17 (19.5%)
Widespread destruction of plants by pests and animals due to lack of fences	15 (17.2%)
Extreme weather conditions e.g. floods and droughts reduce survival rates	12 (13.8%)
Absence of a guiding policy discourage union of purpose among partners	12 (13.8%)

4. Discussion

There are many factors affecting the adoption of both agroforestry and evergreen agriculture. Some factors have a promotional effect on adoption than others. Adoption is determined by several factors including socioeconomic and biophysical factors that are governed by a set of intervening variables such as individual needs, knowledge about the technology and individual perceptions about methods used to achieve those needs (Thangata & Alavalapati; 2003, Noordin, 1996). The importance of socioeconomic factors was further highlighted when all the factors were grouped into two categories where fifteen socio-economic factors as compared to seven biophysical factors affected adoption of agroforestry technologies. This is an important finding as it re-emphasizes the importance of considering socioeconomic context in designing agroforestry and evergreen agriculture technologies. It came out clear that the number of extension visits is very low and most of the existing staff needs more motivation to do quality work. This is in agreement with work of Matata et al. (2010) who argue that extension contact is a key variable in developing a favourable attitude among farmers towards adopting a technology. Low adoption due to lower extension visits implies that extension agents are of paramount importance in changing the mind set of farmers towards adopting agroforestry based technologies. The low number of extension visits is attributed to the low extension staff–farmer ratio in Southern Africa where countries have an average of one extension officer to two thousand (1:2,000) farmers against the standard recommended ratio of 1:500 (Masangano & Mthinda, 2010). Frequent contacts with extension agents may increase knowledge acquisition by farmers through demonstration plots on farmers' fields and this increases their understanding of the technology and improves rate of adoption. Furthermore, there is poor understanding of tree management among extension staff. This is depicted by the low numbers of tree seedlings that survive in comparison to tree seedlings distributed to farmers. In addition, there are minimal extension materials for efficient training of farmers on available agroforestry practices and other integrated land management technologies. It is therefore implied from the study that part of the low levels of adoption can be attributed to low levels of awareness of certain agroforestry technologies. The presence of various research and extension projects from development partners has improved the level of delivery of extension services (Noordin, 1993; Phiri et al., 2004). While most extension workers promoting agroforestry practices argued that incentives in form of cash transfer did not lead to adoption, isolated cases of cash transfer have shown positive effect on adoption. It is likely that what matters is to understand the dynamics in which the incentives are provided. Unlike many cases where incentives were provided for just planting agroforestry tree species the success stories were unique in that the incentive are tied management of the trees at different stages. This meant that farmers were getting cash rewards for survival of tree seedling and better management that eventually led to ownership and adoption of the technology. Farmers were then able to use the cash for other household needs to solve short term socio-economic challenges.

Regarding age, it was learnt that younger households are more risk takers relative to older households and thus likely to adopt agroforestry technologies. This may be because younger people have longer planning horizons and may be more willing to take risks than older people. In addition, management of some of the agroforestry technologies are labour demanding in the initial stages thereby not favouring the category of old farmers. Male household heads have more access to extension services than female household heads thus making it difficult for women in Southern Africa to have adequate access to extension services compared to their male counterparts (Doss & Morris, 2001; (Thangata et al., 2003) . This disagrees with findings of Ipara et al. (1992) who found out that female headed household had more land under trees than male headed households. This explains the role of women in society, which meant they get affected more in case of scarcity of forest resources (Mutoro, 1997). Female headed households experience more socio-economic and socio-culture challenges in adopting agroforestry technologies. Despite these challenges, female headed households are crucial stakeholders in ensuring the wide-scale adoption of agroforestry and evergreen agriculture. Related to extension is the pluralistic approach of extension by different stakeholders both government and nongovernmental organisations that has led to confusion of farmers as sometimes conflicting messages are provided to farmers. Another source of conflict in extension is the competing uses for maize stovers where extension workers promoting livestock production recommend use of maize stovers as feed while proponents of conservation agriculture recommend them to cover soils to improve moisture content, increase organic matter and soil fertility. Another example of conflicting or unclear or confusing messages is the question on the similarity between 'zero tillage', 'minimum tillage' and 'reduced tillage', 'under sowing' and 'intercropping'. It is generally expected that these terms mean the same practice, but some key informants pointed out that this leads to confusion. The confusion over the applicability of conservation agriculture is also compounded by the use of different terms (Mazvimavi & Twomlow, 2009). There is also evidence of conflicting messages on size of pits for maize planting in conservation agriculture with trees. Another factor that determines farmers' adoption is the availability of labour where its shortage has tended to discriminate against categories of farmers when tree production requires a high input of labour (Kerkhof, 1990). Although some agroforestry technologies have been reported to increase maize yields, they are reported to have high initial labour costs especially for pruning and incorporation of biomass. The use of family labour is important in smallholder agroecosystems. Labour is so important that Thangata (2003) found that farmers went on to modify an introduced agroforestry technology in Zomba, Malawi in response to low labour availability. It is important to consider that economic value of trees is a key factor in farmers' adoption (Scherrs, 1995; Ayuk 1997) and the type of tree species available to the farmers for planting. Farmers in most cases tend to accept fast growing tree species that yield benefits early rather than those that have long maturity periods. The other costs associated with conservation agriculture with trees are the cost of herbicides. Herbicides are expensive, hard to find locally and require specialized equipment to apply.

Limited land availability limits the type of technology that farmer can put into practice thereby negatively affecting adoption of agroforestry. This has been reported in areas where there is high population density like Southern Malawi such that the best technology becomes tree-crop intercrop. Agroforestry technologies that require larger piece of land such as tree-crop fallows would be a barrier to adoption by small holder farmers with land of less than 1 hectare. Thangata et al. (2007) reported that farmers in Southern Malawi with small land holdings resorted to adoption of maize tree intercrops of species like *Gliricidia sepium*, *Sesbania sesban, Leucaena* species and pigeon peas. In addition land tenure is crucial in adopting agroforestry as farmers are very willing to invest on land whose security is guaranteed. Farmers feel that if they do not own the land then they cannot own the trees planted on that land (Chitakira & Torquebiau 2010; Kabwe, 2010; Ipara et al., 1992). This is in agreement with findings by Place et al. (2011) where they report that even in matrilineal societies of Southern Malawi where land tenure is under the women, the decision making power of women regarding tree planting is not guaranteed. This agrees with findings of Kwesiga et al. (2003) where farmers are more committed to efficiently manage individual woodlots as compared to communal woodlots. Since most trees take longer before benefits can be reaped multipurpose tree species that provide benefits such as fruits, firewood, grain as in pigeon peas positively contribute to the wide-scale adoption of agroforestry. Research findings as reported by Chintu et al. (2002) confirmed that the use of agroforestry options like biomass transfer for vegetable production and mixed intercropping, that give benefits within the same season facilitated quicker and wider agroforestry adoption. Other agroforestry products such as early wood harvests for fuel and construction from plots have improved adoption rate (Chirwa et al., 2003). Adoption of agroforestry is also limited by national and international policies that promote crop monocultures and input subsidies. In southern Africa, input subsidies and rural credit programmes are usually tied to 'modern' seeds and chemical inputs. For instance in Malawi the Farm Income Subsidy Programme is an important government policy where selected small holder farmers are provided with subsidized fertilizer and hybrid maize seed; this has a direct bearing on adoption of agroforestry and other integrated soil fertility management practices. Malawi, Zimbabwe and Mozambique have no agroforestry policy in place to support implementation of strategies and enhance adoption. Different stakeholders are proposing formulation of a standalone agroforestry policy because the existing policies do not provide for adequate promotion of agroforestry technologies.

Inadequate availability of seed and seedlings is one of the barriers to adoption of agroforestry. Agroforestry seed planted by rural communities is mostly procured through local farmer collection and nongovernmental organizations. In the Southern African region, Forest Research Institutes or Commissions are responsible for production, collection and marketing of agroforestry seeds but they do not have adequate capacity to meet the high demand for agroforestry seed due to low funding by their governments. Some non governmental organizations and community based organisations often carry out their own seed collection to supply seed to farmers directly as a way of cutting costs even through quality, purity and source of the seed is not guaranteed (Pedersen & Chirwa 2005; Nyoka et al. 2011; Phombeya, 2012).

5. Conclusion

Agroforestry generates significant public environmental services such as biodiversity, watershed protection, and carbon sequestration for which market failures exist. Without government involvement in providing enabling policy and greater incentives, the level of adoption will be very minimal. Both biophysical and socioeconomic factors have a bearing on the level of adoption. However socioeconomic factors are more crucial for adoption. Some of the factors limiting wide-scale adoption of agroforestry practices include low extension capacity, high initial costs of agroforestry practices and low access to agroforestry tree seeds. The increased understanding, among farmers, of the connection between land productivity and land quality can be an opportunity that could lead to wide scale adoption of agroforestry practices. Farmer-centered approach to research and development in agroforestry remains the key to wide-scale adoption of agroforestry. This implies that practices recommended for communities and regions should be tailor-made to conforming to the prevalent socio-economic conditions of the farmers. Although some facts about the collected data are unique to Malawi, the publications reviewed show a high potential of applicability of these findings in most parts of the southern Africa region. The factors discussed have some policy implications in that if adoption of agroforestry technologies in Malawi and Southern Africa has to be improved by increasing extension staff to improve contacts with farmers. This suggests that Non governmental organizations and government should focus on strengthening its extension arm to develop more interpersonal contacts with potential adopters. The application of these results is that policy makers, researchers and extension providers should closely work together with farmers in identifying suitable agroforestry technologies on a case by case basis to ensure effective adoption and scaling out.

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References

Ajayi, O. C., & Catacutan, D. C. (2012). Role of externality in the adoption of smallholder agroforestry: Case studies from Southern Africa and Southeast Asia. In S. Sunderasan (Ed.), *Externality: Economics, Management and Outcomes* (pp. 167-188). NY: NOVA Science Publishers.

Ajayi, O. C., Akinifesi, F. K., Mitti, J. M., de Wolf, J., & Matakala, P. (2008). Adoption, economics and impact of agroforestry technologies in southern Africa. In: D. R. Batish, R. K. Kohli, S. Jose, & H. P. Singh (Eds.), *Ecological basis of agroforestry* (pp. 343-360). Taylor and Francis Group/CRC Press, FL.

Akinnifesi, F., Makumba, W., Sileshi, G., Ajayi, O., & Mweta, D. (2007). Synergistic effect of inorganic N and P fertilizers and organic inputs from *Gliricidia sepium* on productivity of intercropped maize in Southern Malawi. *Plant and Soil, 294*, 203-217. http://dx.doi 10.1007/s11104-007-9247-z

Antle, J. M. (1987). Econometric estimation of producers' risk attitudes. *American Journal of Agricultural Economics, 69*(3), 509-522.

Ayuk, E. T. (1997). Adoption of agroforestry technology: the case of live hedges in the Central Plateau of Burkina Faso. *Agricultural systems, 54*(2), 189–206.

Binswanger, H. P. (1980). Attitudes toward Risk, Experimental Measurement in Rural India. *American Journal of Agricultural Economics, 62*(3), 395-407. http://dx.doi.org/10.2307/1240194.

Chintu, R., Mafongoya, P. L., Chirwa, T. S., Matibini, J., & Mwale, M. (2004). Subsoil nitrogen dynamics as affected by planted coppicing tree legume fallows. *Experimental Agriculture, 40*(3), 327-340. http://dx.doi.org/10.1016/S0308-521X(96)00082-0

Chirwa, T. S, Chintu, R, Mafongoya, P. L., & Matibini, J. (2002). Mixed fallows using coppicing and non coppicing tree species for degraded Acrisols in eastern Zambia. *Agroforestry Systems, 59*, 243-251.

Chirwa, P. (2000). Using Leguminous Trees for Replenishing Soil Fertility in Malawi. *Living With Trees in Southern Africa, 4*, 9-11.

Chitakira, M., & Torquebiau, E. (2010). Barriers and Coping Mechanisms Relating to Agroforestry Adoption by

Small holder Farmers in Zimbabwe. *Journal of Agricultural Education & Extension, 16*(2), 147-160. http://dx.doi.org/10.1080/13892241003651407

Clarke, J., & Matose, F. (1992). Agroforestry in Perspective In B. H. Dzowela, & E. M. Shumba (Eds.), *Agroforestry Research and Development in Zimbabwe: Proceedings of the National Seminar held at the University of Zimbabwe from 3 to 5 March 1992* (pp. 121-131). Harare, The National Agroforestry Steering Committee.

Doss, C. R., & Morris, M. L. (2001). How does gender affect the adoption of agricultural innovation? The case of improved maize technology in Ghana. *Agric. Econ., 25*, 27–39. Http://dx.doi:0169-5150/01/$

FAO/REOSA. (2010). Farming for the future in Southern Africa: An introduction to conservation agriculture. (FAO Regional Emergency Office for Southern Africa) REOSA Technical Brief No. 1.

Food and Agriculture Organization of the United Nations. (2006). Eradicating World Hunger taking stock ten years after the World Food Summit: The State of Food Insecurity in the World. FAO, Rome.

Ipara, H. I. (1992). *Socio-economic Factors Affecting the Participation of women in Agroforestry Activities in Sabatia Division in Vihiga, Kenya*. M. Phil. Thesis (Unpublished) Moi University, Eldoret, Kenya.

Franzel, S., Coe, R., Cooper, P., Place, F. S. J., & Scherr, S. J. (2001). Assessing the adoption potential of agroforestry practices in sub-Saharan Africa, *Agricultural Systems, 69*, 37–62. http://dx.doi.org/10.1016/ S0308-521X (01) 00017-8

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme development, *International Journal of Qualitative Methods, 5*(1), 1–11.

Kabwe, G. (2010). *Uptake of Agroforestry Technologies among Smallholder Farmers in Zambia*. PhD thesis, (Unpublished) Lincoln University, New Zealand, 234pp

Kerkhof, P. (1990). *Agrofrestry in Africa, a survey of project experience*. Jolly & Barber Ltd. Rugby, Great Britain.

Kwesiga, F., Akinnifesi, F. A., Mafongoya, P. L., MCDermont, M. H., & Agumya, A. (2003). Agroforestry Research & development in Southern Africa in the 1990s: Review &Challenges Ahead. *Agroforestry Systems, 59*, 173-186.

Kwesiga, F., Franzel, S., Place, F., Phiri, D., & Simwanza, C. P. (1999). *Sesbania sesban* improved fallows in eastern Zambia: Their inception, development and farmer enthusiasm. *Agroforestry Systems, 47*(1-3), 49-66.

Lehmann, J., Peter, I., Steglich, C., Gebauer, G., Huwe, B., & Zech, W. (1998). Below-ground interactions in dry land agroforestry. *Forest Ecol & Management, 111*, 157-169.

Mafongoya, P. (2000). Editorial. *Living with Trees in Southern Africa, 4*, 2.

Makaya, P. R. (2000). Fodder Banks – Chikwaka Dairy Farmers (Zimbabwe) Give Feedback. *Living With Trees in Southern Africa, 4*, 17-19.

Masangano, C., & Mthinda, C. (2012). *Pluralistic Extension in Malawi*. IFPRI Discussion paper 01171. Eastern and Southern Africa office, 68pp

Matata, P., Ajayi, O. C., Oduol, P. A., & Agumya, A. (2010). Socio-economic factors influencing adoption of improved fallow practices among smallholder farmers in western Tanzania. *African Journal of Agricultural Research, 5*(8), 818–823. http://dx.doi: 10.5897/AJAR09.185

Mazvimavi, K., & Twomlow, S. (2009). Socioeconomic and institutional factors influencing the adoption of conservation farming by vulnerable households in Zimbabwe. *Agricultural Systems, 101*, 20–29. http://dx.doi.org/10.1016/j.agsy.2009.02.002

Muhumuza, M., & Balkwill, K. (2013). Factors affecting the success of conserving biodiversity in National parks: A review of case studies from Africa. *International J. Biodiversity, 10*, 1-20 http://dx.doi.org/10.1155/2013/798101

Mutoro, B. A. (1997). Woman working wonders: Small Scale Farming and the Role of Women in Vihiga District, Kenya. A Case Study of North Maragoli. Thesis Publishers, Amsterdam, Netherlands.

Mutua, J., Muriuki, J., Gachie, P., Bourne, M., & Capis, J. (2014). *Conservation Agriculture with Trees: Principles and Practice. A simplified guide for Extension Staff and Farmers.* World Agroforestry Centre, (ICRAF) Nairobi, Kenya.

NEPAD. (2003). *Comprehensive African Agriculture Development Programme*. African Union and New Partnership for Africa's Development.

Noordin, Q. (1996). Community Participation in Agroforestry Development and Extension: The Experience of the Kenya Woodfuel and Agroforestry Programme (KWAP), Busia, Kenya.

Nyoka, B. I., Mng'omba, S. A., Akinnifesi, F. K., Ajayi, O. C, Sileshi, G., & Jamnadass, R. (2001). Agroforestry Tree Seed Production and Supply Systems in Malawi. *Small Scale Forestry, 10,* 419–434. http://dx.doi 10.1007/s11842-011-9159-x

Pedersen, A. P., & Chirwa, P. W. (2005). *Tree seed in Malawi. Organisational survey*. Forest and landscape. Working papers no. 8–2005. University of Copenhagen, Hørsholm, Denmark

Phiri, D., Franzel, S., Mafongoya, P., Jere, I., Katanga, R., & Phiri, S. (2004). Who is using the new technology? The association of wealth status and gender with the planting of improved tree fallows in Eastern Province, Zambia, *Journal of Agricultural Systems*, *79*, 131–144. http://dx.doi:10.1016/S0308-521X(03)00055-6

Phombeya, H. S. K., Banda, G., Dausi, M., Chigwenembe, G., & Phiri, J. (2012). *Annual report*. Land Resource Centre. Lilongwe, Malawi.

Place, F., & Otsuka, K. (2001). Tenure, Agricultural Investment, and Productivity in the Customary Tenure Sector of Malawi. *Economic Development and Cultural Change, 50*(1). http://dx.doi: 10.1086/321918

Randolph, J. (2009). A guide to writing the dissertation literature review. *Practical Assessment, Research & Evaluation, 14*(13), 1–13.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: The Free Press.

Scherrs, S. (1995). Economic Factors in Farmer Adoption of Agroforestry. Patterns Observed in Western Kenya. *World Development, 23*(5), 787–804. http://dx.doi:10.1016/0305-750X (95)00005-W

Sibanda, H. M. (1992). Agroforestry in Communal Areas of Zimbabwe: The Card Programme Experience in Gutu District. In B. H. Dzowela, & E. M. Shumba (Eds), *Agroforestry Research and Development in Zimbabwe: Proceedings of the National Seminar Held at the University of Zimbabwe from 3 to 5 March 1992*. Harare, The National Agroforestry Steering Committee, pp.76-87.

Thangata, P. H., Mudhara, M., Grier, C., & Hildebrand, P. E. (2007). Potential for Agroforestry Adoption in Southern Africa: A Comparative Study of Improved Fallow & Green Manure Adoption in Malawi, Zambia & Zimbabwe. *Ethnobotany Research & Applications, 5*, 67-75. Retrieved from www.ethnobotanyjournal.org/vol5/i1547-3465-05-067.pdf.

Thangata, P. H., & Alavalapati, J. R. (2003). Agroforestry adoption in Southern Malawi: the case of mixed intercropping of *Gliricidia sepium* and maize. *Agricultural Systems, 78*, 57-71. http://dx.doi:10.1016/S0308-521X(03)00032-5