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Smallholder farmers' practices and perception of forest, soil and water conservation Technologies in the Eastern Cape Province of South Africa

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Africa has indigenous natural resource management practices that have been existing many years ago among many diverse ethnic groups. Exploration of such practices can substantially contribute to the nature conservation and welfare improvement in predominately rural areas like the Eastern Cape Province of South Africa. On account of this postulation, this paper reviews selected case studies on indigenous natural resource management practices in Africa. However, the focus is on the survey of farmers' practices, knowledge and perception of forest, soil and water conservation (SWC) in the Eastern Cape Province of South Africa. Soil erosion is one of the major challenges threatening smallholder agriculture in South Africa. The study shows that there are local forest management practices that can be promoted to wider scale of application in the study areas. However, the local people have limited exposure to SWC measures. Very few farmers have knowledge on local and modern stone bund terracing for the purpose of SWC. Due to lack of awareness, many farmers do not practice SWC measures. These findings have important implications for policy development to achieve sustainable rural development in the study areas.

Key words: Natural resources management, forest, soil and water conservation, smallholder, farmers, Eastern Cape, South Africa.

INTRODUCTION

Since the 1990s, there have been national and global initiatives to identify local level indigenous natural resource management practices. In most African countries, such practices are often neglected by practitioners and the attempt to integrate them with scientific practices has been limited. On account of this, most dry land

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African countries have already being affected by the consequences of land degradation, climate changes and desertification (IPCC, 2014; Kong et al., 2014; Lal et al., 2012). East Africa and South Africa would be particularly vulnerable to climate-related changes (IPCC, 2014). These changes have serious socioeconomic and ecological implications. The other aspect that makes Africa vulnerable is heavy dependence on rain-fed agriculture, frequent floods and droughts, and poverty.

Moreover, adaptive capacity to these changes is low because of limited financial resources, poor skills and weak institutional capacity (IPCC, 2014). These problems call for identification and implementation of sound natural resource management (NRM) practices in the continent (in a broader term NRM in this study refers to the sustainable utilization of major natural resources, such as land, water, air, minerals, forests, fisheries and wild flora and fauna. Together, these resources provide the ecosystem services that underpin human life (Orquebiau and Taylor 2009). To reverse such adverse situations, there is a potential to use the existing indigenous forest, soil and water conservation (SWC) measures among many diverse ethnic groups in integration with scientific practices prevailing (Dreber et al., 2014). These measures are effective ways of improving water resources management and of reducing the degradation of soil, vegetation and biodiversity (Ackermann et al., 2014).

The objective of this study was to survey the existing forest and soil and water conservation (SWC) practices in two magisterial districts: Tsolo and Lusikisiki in O.R. Tambo district in the Eastern Cape Province of South Africa. Review of few of such practices in the four selected sub Saharan Africa (SSA) countries is presented to deduce some valuable lessons to be applied in the study areas.

Forest resources in South Africa are valued for their livelihood functions, biological diversity, medicinal and local uses and aesthetic and spiritual values (Cocks and Wiersum, 2003; Cocks and Dold, 2006; Shackleton et al., 2001; Makhado et al., 2009; Paumgarten and Shackleton, 2011). However, natural forest base of the country is small, highly exploited and fragmented and often subject to adverse impacts from surrounding land use (DWAF, 1995). South Africa is among the least forested countries in the Southern African region (Naidoo et al., 2013).

Moreover, South Africa is a water scarce country relatively with high levels of pollution among developing nations (National Treasury, 2010). Given this context, this study attempts to answer the following research questions. What are the farmers' practices and perception of forest, soil and water conservation in the study areas? What lessons can we derived from the local and selected African experiences to improve the natural resources management practices in the study areas?

NATURAL RESOURCES MANAGEMENT CHALLENGES AND PRACTICES

The NRM challenges

Indigenous or traditional natural resources management practices in Africa also known as 'ethno-engineering' include terracing mountain slopes, agroforestry, harnessing the runoff and developing small drainage systems (Jodha, 1990). Until recently, farmers were not able to benefit from research-based solutions and were forced to develop innovative and experimental plans to improve their farming practices (O'Neil, 1995; Chinkhuntha, 2004). Several factors have contributed to the many challenges smallholder farmers face in adopting and adapting to natural resources management practices in many African countries. Such factors range from the poor technological performance to policy and institutional deficiencies (Shiferaw et al., 2007).

In Africa, the adoption and scaling up of indigenous natural resources management practices have been hampered for a number of reasons. Farmers' practices have been downplayed and neglected by scientists. In the past indigenous practice, particularly in the African context, has long been ignored (Warren, 1992). For example, even though there are successful and worthy local practices of natural resources management in Ethiopia, there are multifaceted challenges faced by innovative small holder farmers. Challenges like negligence towards local practices and bias to standard structural SWC practices, lack of financial support, and government owned land tenure system may force land owners not to invest in long lasting SWC measures like planting perennial crops or trees (Mitiku et al., 2001; Tesfaye, 2003; Mitiku et al., 2006). In recent years, however, a growing number of African governments and international development agencies are recognizing that local-level practice and organizations provide the foundation for participatory approaches to sustainable social, political and economic developments (Dreber et al., 2014). Such challenges are often common across the continent and need to be addressed for the welfare of rural communities and for the conservation of our natural environment and biodiversity.

NRM Experiences from few SSA countries

This section focuses largely on documenting SWC practices from mountainous high lands of Ethiopia, important cases from Burkina Faso, Cameroon and South Africa, respectively. We showed that there are lessons to learn from the experiences of these countries.

The bench terrace '*kaha*' by the *Konso* people, '*daldal*' dams to trap silt water by *Irob-Tigre* people and *Gedeo's* agroforestry systems are best among the important

Investigation into the terracing practices used by Venda people in the Limpopo Province has shown that these systems have long been used, and that their primary purpose appears to be the conservation of fertile soils. In this relatively densely settled, well watered area of fertile apedal soils, land is allocated to individuals, and "the right to cultivate is effectively inalienable, and is inherited from father to son". Using participatory methods, researchers investigated farmers' perceptions of the problems they were addressing by building stone terraces in their hillside fields. They described the problem in terms of "loss of fertile soils", and most noted that this loss was being arrested by the construction of the terraces and associated measures (grass strips, contour ploughing, construction of diversion ditches above fields, check dams in gullies, etc.). Despite ancient examples of terracing existing nearby, much of the terracing is recent, and could be a response to increase pressure on the land by a growing population.
Source: Taken from (Oettle et al. 1998; Lotter et al., 2009)

Box 1. VhaVenda terraces in South Africa.

attributes of indigenous practice in agricultural development in Ethiopia (Meire et al., 2012; Mitiku et al., 2006; Tesfaye, 2005*).* The *Konso* SWC terraces are internationally recognized and registered by UNESCO. *Konso* are also well known for their crop diversification to minimize risk, mixed cropping and multi-story crop and tree production in traditional intensification (Mitiku et al., 2006).

As a result, the *Konso* people have controlled land degradation in hilly and mountainous areas where each terrace has been in place for over 50 years. Konso SWC terracing and agroforestry practices have a significant contribution in combating desertification and mitigating the effects of drought. Such practices can be replicated in similar agro climatic regions in the African continent. The innovative *'daldal'* technique by many Irob people aids in creating arable land and supplying clean water. The practice is sustainable in environmental terms, reduces soil erosion and makes use of soil and water that would otherwise have flowed into barren depressions and been wasted (Asfaha and Waters-Bayer, 2001; Reij and Waters-Bayer, 2001).

In *Gedeo* agroforestry system, nearly all the people live virtually in a home-garden land-use system (Tadesse, 2002). *Gedeo* agroforests contain an organized mix of crops, '*enset'* (*E. ventricosum*) is commonly known as "false banana" for its close resemblance with the domesticated banana plant. It is Ethiopia's most important root crop, a traditional staple crop in the densely populated south and Southwestern parts of Ethiopia) and coffee to long living multi-purpose trees to get maximum benefits on a sustainable basis. As a result, soil and water resources are well conserved and home garden agroforestry and biodiversity have been enhanced; and most areas are covered by evergreen vegetation. These agroforestry practices have been seen as one of the best measures to combat desertification and mitigate the effects of drought in the area (Mitiku et al., 2006).

Furthermore, there are traditional SWC practices that are widely common and practiced by different ethnic groups in many West African countries like Burkina Faso and Cameroon (Reij, 2001). For instance, a widespread indigenous practice of the 'zai' pit SWC and soil fertility strategy in Burkina Faso is widely known. In the South Sahelian area with 400-700 mm rainfall, farmers have been practicing runoff farming, such as the *Mossi* in the *Yatenga* region of Burkina Faso, use stone bunds, planting pits, mulching, etc.

Although, twenty different ethnic groups practice water harvesting in the *Mandara* Mountains of Northern Cameroon, the *Mafa* are the most skilled practitioners (Riddell and Campbell, 1986). Farmers have complicated system of indigenously developed terracing of steep slopes. For soil fertility management, they use household animal wastes and crop residues. Manure is spread into the soil; and they practice natural resources management practices like crop rotation, intercropping, silvopasture (Latin, silva forest) is the practice of combining forestry and grazing of domesticated animals in a mutually beneficial way. Advantages of a properly managed silvopasture operation are enhanced soil protection and increased long-term income due to the simultaneous production of trees and grazing animals). The two most important trees growing on the terraces of West African countries are *Acacia albida* and *Khaya senegalensis*.

Up until now, South Africa has been included under World Overview of Conservation Approaches and Technologies (WOCAT) project in 1998 and has started implementing the Land Degradation Assessment in Dry Lands (LADA) project, indigenous knowledge systems were poorly understood and their integration into modern agriculture was practically non-existent.

The WOCAT/LADA projects have identified natural resources management approaches and technology questionnaires are included in the South African data-base (Lotter et al., 2009*)*. For example, there is evidence of traditional approaches to soil conservation by "*VhaVenda"* people in Limpopo Province (Box 1). The *VhaVenda* terraces are among the WOCAT/LADA projects included in the data base. However, there is no endeavour to integrate this traditional SWC practice with scientific practices and it is not widespread across the country.

- **Proposition 1**: While modifying natural vegetation for their productive use, farmers develop and maintain agroforestry systems that make substantial contributions to biodiversity in multi-functional landscapes.
- **Proposition 2**: The increased uptake of agroforestry in multi-functional landscapes can reduce pressure on forests and protected conservation areas.
- **Proposition:** 3 Agroforestry can create habitat for wild species in landscape matrices surrounding forest conservation areas.
- **Proposition:** 4 Agroforestry developments can be implemented in a way that reduces the risk of alien invasive species to acceptable levels, if adequate precautions are taken.

Source: Swallow et al. (2009)

Box 2. Agroforestry and biodiversity.

In additions to SWC practices discussed above, agroforestry practices have considerable potential in helping solve some of Africa's main land use problems (Cooper et al., 1996; Sanchez, 1995) through provision of a wide range of tree products for domestic use or sale (Franzel et al., 2001). As shown in Box 2, Swallow et al. (2009) claimed that agroforestry farming can contribute to biodiversity conservation which needs further investigations in the context of South Africa.

METHODOLOGY

The survey was conducted from December 2011 to June 2012 in two magisterial districts: *Tsolo* and *Lusikisiki* in O.R. Tambo district in the Eastern Cape Province of South Africa. These study sites were selected because of their predominantly rural nature and an urgent need for the integration of natural resource management with rural development in the province to address the prevailing major socioeconomic and environmental problems (Figure 1).

In this study, the mixtures of purposive and systematic random sampling methods were used to draw the final sample from Tsolo and Lusikisiki areas in O.R. Tambo district in Eastern Cape Province of South Africa. A detailed questionnaire was used to answer the research questions posed in the introductory section. The questionnaire included both open ended and closed questions. In addition, focus group discussions were carried out with participants comprising experts, professionals and opinion leaders from local agencies working in relation to rural developmental.

However, there could be a possibility that responses would be distorted due to personal biases by both the interviewees and the interviewer. The training of enumerators and the increased number of responses may help reduce these biases. The questionnaire has many sections, however, the sections analyzed in this study are based on two main issues, namely local forest-resource management and SWC measures in the study areas. The questionnaire was administered in local language by local research assistants recommended by Tsolo Agricultural and Rural Development Institute.

RESULTS AND DISCUSSION

General characteristics of the respondents

This section provides a general description on the respondents included in the survey. A total of 300 respondents were included in the survey of which 53 percent are females and 43% are males. The number of respondents by district and gender is presented in Table 1. Female respondent are higher in *Tsolo* while male respondents are higher in *Lusikisiki*. The average household size is 7.14 (the maximum household size is 16 and the minimum is 1). The two study sites *Tsolo* and *Lusikisiki* have the population density of 132-193 and 194-600 person per square kilometer, respectively. These two magisterial districts are among densely populated areas in O.R. Tambo district.

As shown in Appendix 1, close to 32% of the respondents are in the age group of 50-59. Male respondents are more dominating in the female counterparts in this age group of 36.4 and 26.1%, respectively.

As shown in Appendix 2, 82% of the respondents have acquired either adult education or beyond. Only 13% of the respondents had tertiary level education. In all the levels of education, except 'some secondary education' level, male respondents dominated the female counterparts.

Analysis of NRM practices in the study areas

Here, we discussed the level of local knowledge in NRM practices and perceptions of farmers on these practices in the two study areas. In the study areas, smallholder agriculture is dominant livelihood practice owned and operated by smallholder farmers. We had a series of discussions with the research assistants and respondents to make sure that they understood what is meant by local knowledge or indigenous practices in NRM.

The purpose of investigation and discussion of these practices in this section is with the conjecture that integration of modern, science based NRM technologies with the local knowledge is instrumental to ensure sustainability in integrated rural development endeavors.

Value, attitude and use of indigenous practice in NRM

The respondents were asked whether they use indigenous

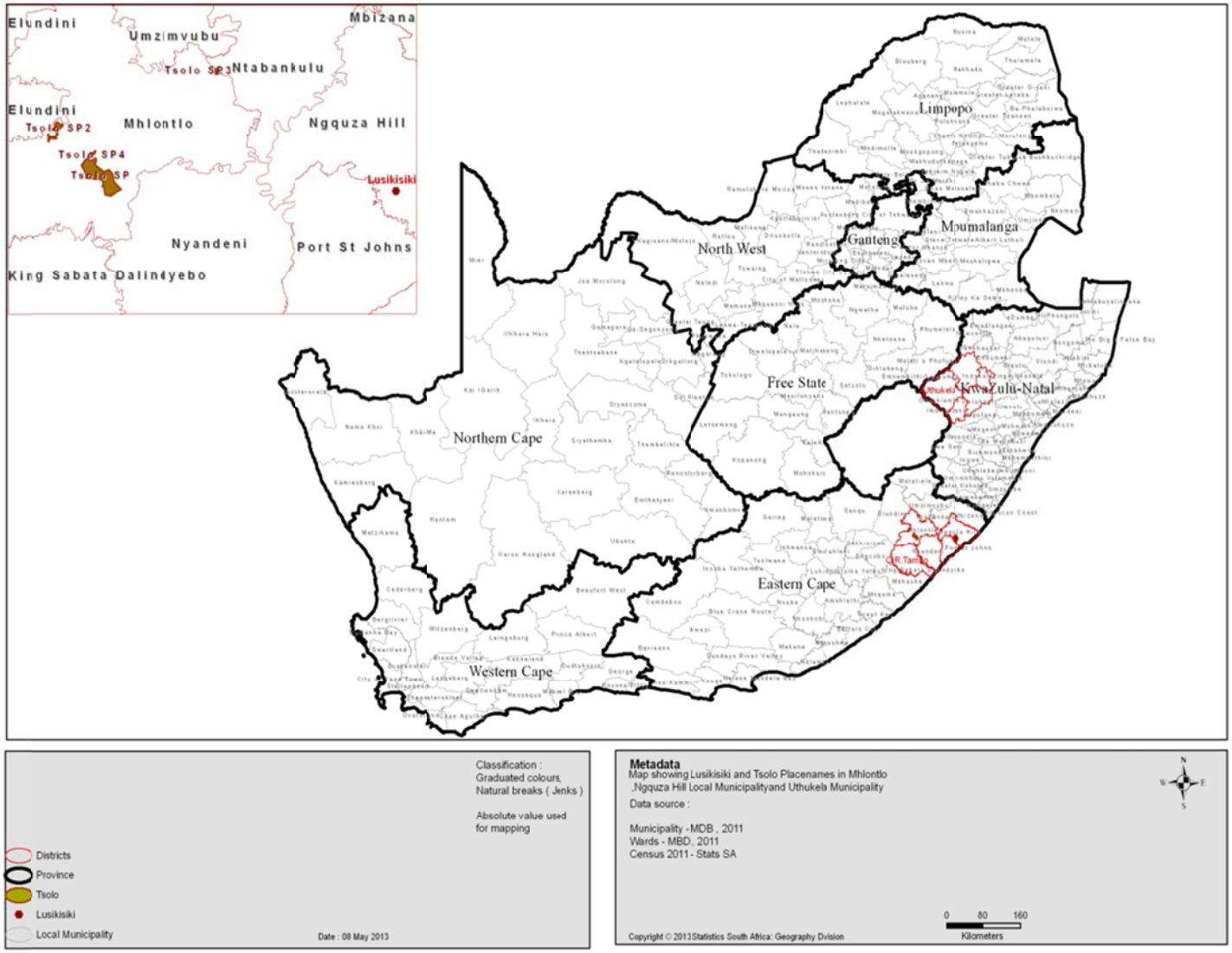

Figure 1. Map of the study sites.

Table 1. Number of respondents according to district and gender.

Gender of the respondents						
District	**Female**		**Male**		**Total**	
	%	**N**	**%**	**N**	**%**	**N**
O.R. Tambo- Tsolo	53.0	85	46.0	65	50.0	150
O.R. Tambo- Lusikisiki	47.0	75	54.0	75	50.0	150
Total	100.0	160	100.0	140	100.0	300

Source: authors, computed from survey data.

practices in NRM. Overall, as indicated in Table 2, more than 66% of the respondents confirmed that they use indigenous practice in NRM. Moreover, the attitude towards indigenous practices in NRM is overwhelmingly positive. As shown in Table 3, more than 75% of the respondents value the worth of NRM practices in their localities.

Table 2. Indigenous practice in NRM.

Do you use indigenous practices in NRM?	District					
	Tsolo		Lusikisisi		Total	
	%	N	%	N	%	N
No	33.6	41	54.2	64	43.8	105
Yes	66.4	81	46.0	54	56.2	135
Total	100.0	122	100.0	118	100.0	240

Source: Authors, computed from survey data.

Table 3. Attitude towards traditional/indigenous NRM practices.

Attitude towards indigenous practice in NRM	District					
	Tsolo		Lusikisisi		Total	
	%	N	%	N	%	N
Do not value NRM	5.2	7	14.3	17	9.4	24
Value NRM	88.1	119	60.5	72	75.2	191
Do not know	6.7	9	25.2	30	15.4	39
Total	100.0	135	100.0	119	100.0	254

Source: Authors, computed from survey data.

Table 4. Reasons for not planting trees.

Reason for not planting trees (exact words as suggested by respondents)	
Afraid it will bring snakes	Infertile land
Fear of damage by the free grazing animals in the vicinity,	My farm land is too small, I only cultivate vegetables
Lack of sufficient land,	My land is not fertile
Lack of experience,	No capital
Unavailability of tree seedlings	No money to nurture tress
Lack of knowledge	No need for planting trees now
Expenses	Roots destroy houses
Lack of space for planting trees	

Source: authors, extracted from survey data.

Indigenous tree and forest development practices

Table 4 highlight that some of the reasons why farmers have not planted trees. There are arguments listed in Table 4, however, there are also cultural believes like “trees will bring snakes” which are against tree planting initiatives in the localities.

Local practices listed in Table 5 will be instrumental to arrest land and natural forest degradations in the study areas and in the entire province. Scaling up such practices can substantially augment Government’s policy towards environmental protection. Table 5 summarises major indigenous NRM practices used in the forest management in the study areas.

The next question posed to the respondents was to request the degree of dependence on indigenous and modern practices in NRM. As shown in Table 6 most of the respondent uses both indigenous and scientific practice in their NRM endeavours. Here when we say scientific practices we are referring to practices often suggested by extension officers to smallholder farmers in the study areas.

Soil and water conservation (SWC) practices in the study areas

The respondents were also asked whether they had

Table 5. List of major indigenous tree and forest development practices in the study area.

List of major indigenous (local) NRM practices	District					
	Tsolo		Lusikisisi		Total	
	%	N	%	N	%	N
Wood lot establishments	4.2	6	.6	1	2.2	6
Ask for permission from leaders	6.3	9	3.8	6	5.0	15
Certain forest parts are preserved	3.5	5	1.9	3	2.7	8
Choice of seasons to cut trees	0	0	1.3	2	0.7	2
Farming trees with crops (Agroforestry)	9.9	14	1.9	3	5.7	17
Fire belt around forest	3.1	3	0.6	1	1.3	4
Pay for cutting trees and grass	0	0	7.6	12	4.0	12
Traditional wild fire management	0.7	1	0.0	0	0.3	1
Pruning trees	7.7	11	0.6	1	4.0	12
Removing unwanted trees	0.0	0	1.2	2	0.6	2
Rotational grazing practice	0	0	0.6	1	0.3	1
Selling aged trees in communal lands	0	0	0.6	1	0.3	1
Area closure	1.4	2	0	0	0.7	2
Use of forest guards to protect communal forests	0	0	3.1	5	1.6	5

Source: authors, computed from survey data.

Table 6. The degree of dependence on indigenous and modern NRM practices.

Degree of dependence on	District					
	Tsolo		Lusikisisi		Total	
	%	N	%	N	%	N
Indigenous Practices	5	7	12.0	19	11.0	26
Modern Practices	15	19	28.0	33	21.0	52
Both	80	100	60.0	66	68.0	16
Total	100.0	126	100.0	118	100.0	245

Source: authors, computed from survey data.

exposure to any traditional or scientific SWC practices. Less than one third of the sampled households answered this question. The reason is that most of the respondents in the study areas do not practice SWC on their farms. Only 113 respondents have exposure to local and modern stone bund terracing in both study sites (Figure 2). '*Fanajo*', grass planting, cut-off drain, check dam, flood diversion and other SWC measures are not known in their areas. However, soil erosion is among the most common environmental problems in Eastern Cape Province due to its mountainous topography.

All the stakeholders working for the betterment of the environment should work jointly in introducing SWC techniques to the farming system. Those who have been implementing SWC measures on their farms were asked why they practice such measures given the categories to choose from. Figure 3 depicts the reasons for practicing SWC measures on farm lands. Maintaining soil fertility status, reducing the risk of floods, conserving soil moisture, and combination of all those reasons justify practicing such measures.

As depicted in Figure 4, the most important reason for not practicing SWC measures in the study areas is lack of awareness. The Department of Agriculture, Forestry and Fishery (DAFF) in collaboration with Department of Environmental Affairs (DEA) need to formulate a strategy to create awareness among stakeholders on SWC in the study areas.

Conclusions

Natural resources management practices that include upgrading existing indigenous practices can play a significant role in reducing the degradation of soil, improving soil fertility, plant cover and biodiversity toward

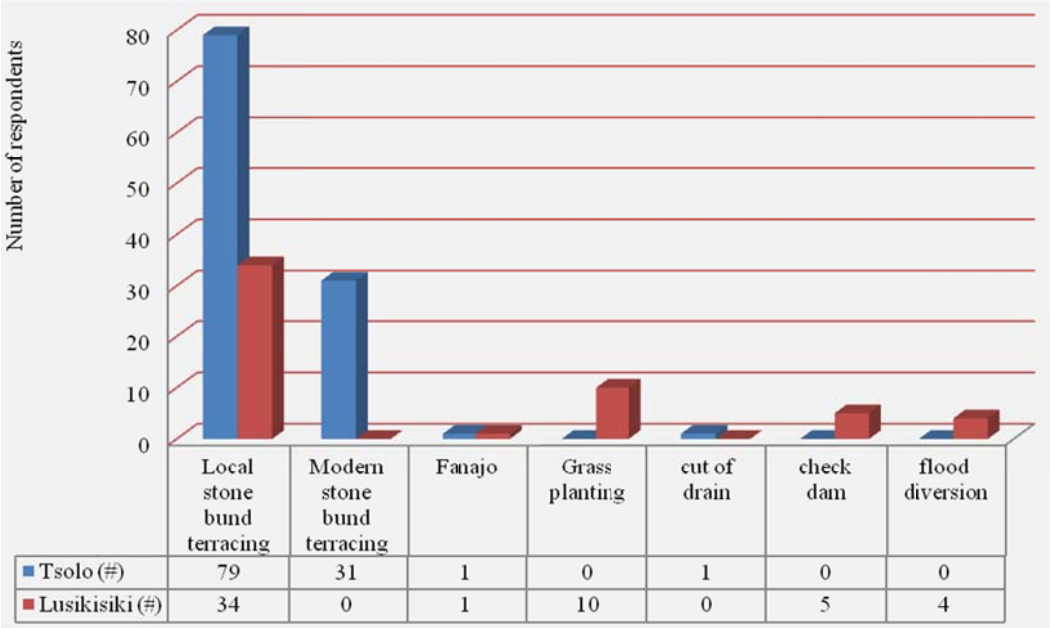

Figure 2. Experience of SWC measures in the study areas. Source: authors, computed from survey data.

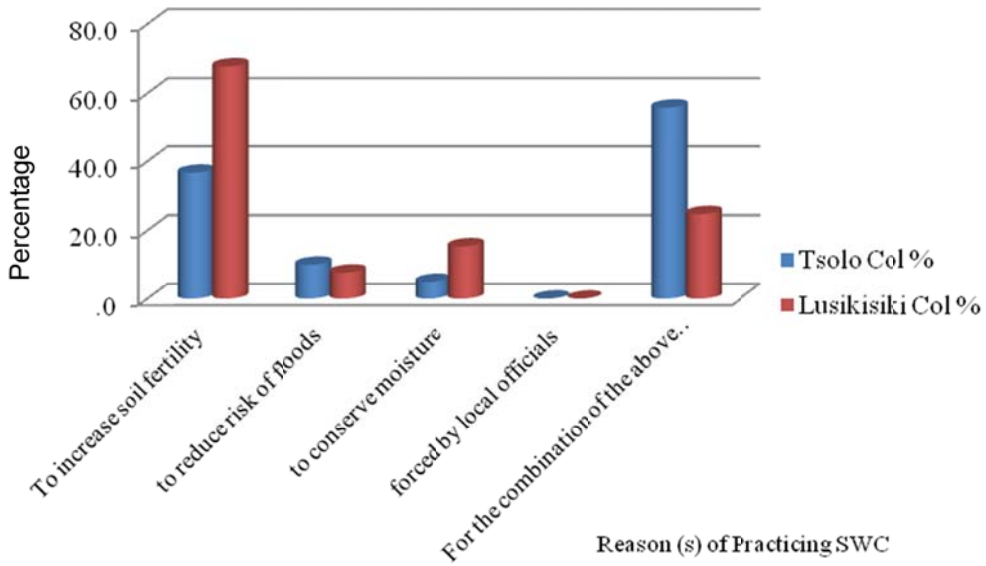

Figure 3. Reasons for practicing soil and water conservation measures. Source: authors, computed from survey data.

more secure livelihood and higher standard of living for rural communities. Experiences from SSA indicate that it is crucial to integrate local natural resources management practices with new scientific technologies into the farming systems of smallholder farmers in the study areas according to their financial status, age and social circumstances.

Exploration of indigenous natural resource management practices can substantially contribute to the conservation of nature and the improvement of welfare in predominately rural areas like the Eastern Cape Province of South Africa. The study shows that there are valuable

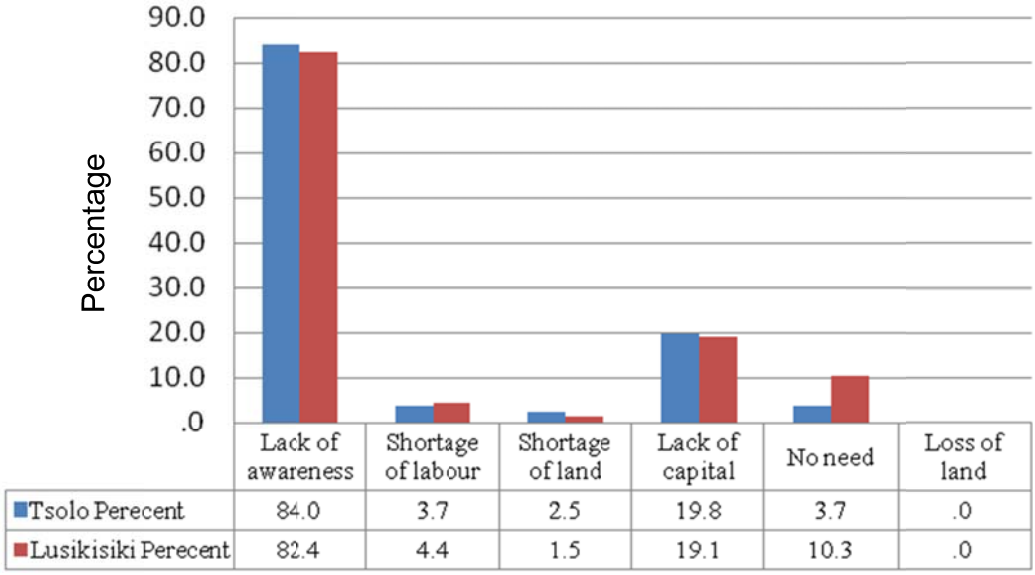

Figure 4. Reasons for not practicing soil and water conservation measures. Source: authors, computed from survey data

practices, knowledge and perception in forest, soil and water conservation in the Eastern Cape Province of South Africa. The rural people in the study areas have greater values attached to indigenous knowledge in forest and soil, and water conservation measures. They have developed positive attitudes towards indigenous knowledge in forest management. For example, the respondents have knowledge on wood lot establishment, they are aware of tree management , make use of traditional wild fire protection measures, practice farming of tress with crops (agroforestry), they participate in local enforcement measures towards environmental protection (Table 5). Scaling-up such practices can supplement governmental policy towards environmental stewardship and food self sufficiency in the areas. However, the local people in the study area do not have exposure to soil and water conservation measures. There are also major constraints hampering tree planting in the study areas, they are free grazing, financial constraints, small land size, lack of experience and know-how of tree management among youngsters, unavailability of public tree nurseries nearby and others.

The Department of Agriculture and Forestry should facilitate financial credit services and incentive scheme for those framers who have the experience and willingness to practice forest, soil and water conservation measures in the study areas and across the country. Training in soil and water conservation techniques to the farmers and extension agents would assist in reversing the current situation of soil erosion in the study areas. Training should be given to farmers on tree management practices (such as pruning, thinning and coppicing, etc.) and to individual tree and stand manipulation to reduce adverse ecological interaction with agricultural crop components of the system. The local government institutions can intervene to address problems associated with free grazing and supply of trees seedlings. It may be also worthy to learn best practices on forest, soil and water conservation from experiences of similar agro climatic regions in the African continent.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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Appendix 1. Age groups of respondents (number of respondents).

Age group	Gender HH					
	Female		Male		Total	
	%	N	%	N	%	N
20-29 years	0.6	1	1.43	2	1.0	3
30-39 years	5.6	9	13	18	8.5	25
40-49 years	12.4	20	14.3	20	12.2	36
50-59 years	26.1	42	36.4	51	31.5	93
60-69 years	26.1	42	20.7	29	24.1	71
70+ years	29.2	46	14.3	20	22.7	67
Total	100.0	160	100.0	140	100.0	300

Source: Authors, computed from survey data.

Appendix 2. Education levels attained by farmers in the sample area.

Level of education	Female		Male		Total	
	%	N	%	N	%	N
No formal education	17	27	20	28	18	55
Adult Education	3	5	3	4	3	9
Some primary education	18	28	14	19	16	47
completed primary education	9	14	4	6	7	20
Some vocational education	0	0	4	5	2	5
Completed vocational training	3	5	8	11	5	16
Some secondary education	31	50	29	40	30	90
Completed secondary	9	14	4	6	7	20
Advanced level	1	1	4	5	2	6
College education	4	7	4	5	4	12
University education	6	9	8	11	7	20
Total	100	160	100	140	100	300

Source: Authors, computed from survey data.