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# The role of Indigenous Knowledge in Land Management for Carbon Sequestration and Ecological Services in Southern Ethiopia

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**Abstract**

The significance of Indigenous Knowledge [IK] systems in management of sustainable ecosystems has long been recognized. This study reflects the role of IK in sustaining ecosystem services and contributing to carbon sequestration among the Wolayta people in Damot-Sore District, Southern Ethiopia.

The study applied an ethno-ecological approach using key informants, group discussions, village-dialogues and validation methods. Expert rating of land management practices and comparison of land suitability classifications systems was also used. Although past development has overlooked IK, this study reflects the significance and wealth of IK as exhibited in the diversity of practices, terminology, and land suitability classification system. Among the nine land management practices observed, indigenous agro-forestry has the highest potential in contributing to carbon sequestration, mitigating climate change and sustaining soil ecosystem services. Croplands have the most diverse and widely used indigenous land management practices compared with forests and grass lands. The study recommends further quantitative valuation and integration of appropriate practices in development intervention.

**Key words:** Ecological services, Ethiopia, Indigenous Knowledge, Land management, Soil carbon.

## 1. Introduction

### 1.1 *General overview*

The importance of Indigenous Knowledge [IK] in sustainable ecosystem management has been well-recognized and it is now gaining increasing attention (Warren and Rajasekaran 1993: 8; Kolawole 2001: 4; Samal *et al,* 2010: 140). The gap between scientific and indigenous knowledge is declining as scientists and indigenous people are collaborating in many parts of the world (Reijntjes 2004: 41). Today, farmer's knowledge which was considered in the past as irrelevant, is now considered as relevant and sophisticated insight (Chambers, 1983: 5-8; Kolawole, 2001: 4). It is, however, good to note that IK is not in itself capable of addressing all of the issues in sustainable ecosystem management (Tripathi and Bhattarya, 2004: 3). In an agro-ecosystem, farmers' indigenous practices can lead to both to a sustainable and unsustainable management (Bellon 1995: 263; Dixon, 2002: 6, Kelbessa, 2005: 17). Nevertheless, the importance of integrating IK into contemporary ecosystem management is taken as a step to overcome problems of global concern like climate change and unsustainable ecosystem services (Rist and Dahdouh-Guebas; 2006: 467).

The term indigenous knowledge has various meanings (Food and Agriculture Organization [FAO], 2005: 7; Boillat, 2008: 82-83). There is, however, general agreement that the terms like "indigenous or local knowledge", "traditional (community) knowledge", "indigenous traditional knowledge", "traditional ecological (environmental) knowledge [TEK]" and "rural peoples' knowledge" are all used for knowledge belonging to local people (Tripathi and Bhattarya, 2004: 3; UNEP, 2008: 22). TEK came into wide use in the 1980s (Inglis, 1993: 1). The term indigenous knowledge (IK) is used to distinguish knowledge developed by a given community over several generations as opposed to the scientific knowledge (Herweg, 2002: 679; Kolawole, 2001: 4; Ajibade 2003: 99-100; Tripathi and Bhattarya, 2004: 3). IK is an institutionalized knowledge that passes from one generation to another and develops within a certain culture or ethnic group and strives to meet subsistence goals in a particular ecological setting (Ajibade, 2003: 99). IK is unique knowledge developed over time and continues to develop by people in a given community or geographic area (Samal *et al.* 2010: 140; International Institute for Rural Reconstruction [IIRR] 1996: 20; FAO 2005: 7-8; Mitiku *et.al,* 2006: 181). A comparative review of both IK and scientific knowledge is available in Inglis (1993: 2-6). In this paper, the term indigenous knowledge and local knowledge are used synonymously.

IK plays an important role in sustainable management of ecosystems and can also have a role in addressing problems of global concern (Tripathi and Bhattarya, 2004: 2). Indigenous people have extensive knowledge in managing landscapes (Mathiui and Kariuki, 2007: 536) with their own land management experimentation making them more innovative (Reijntjes 2004: 42). These local innovations make indigenous practices contribute to sustainable management of ecosystem and carbon sequestration. Lal (2004: 9-11) describes carbon sequestration as technological option to mitigate climate change. The role of land management and carbon sequestration has been well reviewed by FAO (2001). The term "sequestration" is equivalent to the term "storage" (FAO, 2001: 3) and carbon sequestration is the accumulation of carbon (organic matter) in sinks like soil and vegetation from the atmosphere through using sustainable land management practices.

De Groot, *et al.* (2002: 394) describe ecosystem services as "capacity of the environment to provide goods and services to satisfy human needs". From a functional point of view there are four types of services: productive, supportive, regulative and recreational. Carbon sequestration is part of the bio-geo-chemical cycle, which can be considered as regulative function of ecosystem services (De Groot, et al., 2002: 397). Studying the role of indigenous knowledge in land management contributes to better understanding on how to sustain ecosystem services, adapt to climate change and paves way to integrate indigenous practices into development initiatives. Studying the role of IK enables the use of transferable indigenous knowledge [TIK], which has the potential to be applied to other sites also (Inglis, 1993: 35; Shaw and Sharma, 2007: 3; Srivastava, S., 2009: 410). It also paves the way for the protection of indigenous knowledge and their environment (Davis and Wali, 1994).

Although a vast heritage of indigenous knowledge exists on ecosystems, it is not well documented to be available in literature (Warren, 1992: 8). There is a need to document indigenous knowledge (Kolawole, 2001: 4). In Ethiopia, there are over 80 ethnic groups (Cosoleto, 2010: 3) living under varied climatic conditions with diverse ecosystems and rich bio-diversity (Plant Genetic Resources Center [PGRC], 1995: 5-6). With such diverse agro-ecology, rich bio-diversity and existence of multi-ethnic groups, each ethnic group may have a unique way of managing its ecosystem. This study hypothesizes that indigenous knowledge in land management has a vital role in sustaining ecosystem services and in contributing to carbon sequestration among the Wolayta ethnic group in Southern Ethiopia. IK might have contributed a lot to the maintenance of the present-day ecological bio-diversity against the past natural and social problems in Ethiopia. In spite of government and partners' effort on soil conservation since the mid-1970s (Environmental Protection Authority of Ethiopia [EPAE], 1989), little is known on the role of IK, especially in sustaining ecosystem services and sequestering carbon to mitigate climate change. Moreover, except for Hurni (1984) and Kruger et al. (1996), there have not been much efforts to understand the wealth of IK focusing on land management and review past ethno-ecology in Ethiopia. The aim of this study is to reflect the importance of IK from ecosystem services and soil carbon sequestration perspective in Southern Ethiopia. In Southern Ethiopia, the Wolayta Zone is an appropriate site for studying IK owning to its varied agro-ecology and existence of rich bio-diversity and different agro-ecologies leading to the existence of diverse land management practices. The study site, Damote-Sore, is situated in an *enset*-farming environment where livestock and crop production are integral part of the farming system (Fekadu, 2009), and where *enset* is used as a staple crop along with root crops and cereals have minor importance.

This paper adds value to ethno-ecology research in Ethiopia in four ways. First, it gives an overview of past ethno-ecology research in Ethiopia. Second, it shows the wealth of IK in the study area. Third, it reflects the role of IK in technology adoption, sustaining of ecosystem services with a focus on carbon sequestration and climate change adaptation. Fourth, it shows why IK has not played its expected role as a result of changing socio-economic conditions where land degradation is prevalent.

### 1.2 *Ethno-ecology review in Ethiopia*

Past research on indigenous knowledge has paid little attention to Africa (Kelbessa, 2005; 17). There is poor record, lack of appreciation of IK and less attention was given to indigenous land management by experts, researchers and policy makers in Ethiopia (Reij, 1991:12, Mitiku et al, 2006; 26). However, most farmers in Ethiopia are aware of soil related problems and have attitude to conserve land at farm level. Although less attention was given to IK, it has remained an important, yet unnoticed wealth of knowledge for sustainable management of ecosystem.

In Ethiopia, an early study on IK was carried out in 1983 by Hurni (1984) and a more detailed study was continued by Alemayehu in 1992, Kruger *et al.* in 1996 and Gebere Michael in 1996 as cited in Soil Conservation Research Programme [SCRP] (2000). The early studies by Gebere Michael (1998) and Alemayehu

(1992) focused on indigenous soil and water conservation. The role of IK in pastoral areas for climate change adaption was described in Gebre Michael and Kifle (2009). Other studies showed the role of IK in improving soil fertility, increasing crop yield and reducing erosion (Elias 1997; Haileslassie *et al.*, 2006; Amede *et al.*, 2001, Reij, 1991, Nyssen, *et al*., 2000, Pound and Jonfa, 2005, Herweg, 2002, Assefa, 2007, Erkossa and Ayele, 2003). The role of IK in overcoming labor shortage is described in Herweg (2002; 681-682) and Ministry of Agriculture and Rural Development [MoARD] (2010;22). A description of indigenous water harvesting, agro-forestry and soil and water conservation in Ethiopia was undertaken by MoARD (2010) and Liniger *et al.* (2011) while the African Highland Initiative [AHI] (1997: 34-35) describes indigenous practices of burning heaps of soil mixed with manure "*guie*" in the Ethiopian highlands.
The role of IK in wetland management has been documented in relation with combating desertification (Dixon, 2002). Most studies in the past have not examined the geographic variation of IK practices, except for Assefa (2007; 28) which focused on terracing. Studies by Abera and Belachew (2011) and Tegene (1992) indicate IK existence though it focused on farmer's perception. Pound and Jonfa (2005; 11-15) examined indigenous soil classification while Mitiku *et al.* (2006; 107) indicates the existence of numerous traditional plowing systems in Ethiopia. Compared with available documents on ethno-archaeological (Weedman, 2006; 187) ethno-veterinary (Mesfin and Obsa, 1994; 417), ethno- botany and ethno-medicine studies (Addis et al, 2005; 85), studies on ethno-ecology are scarce. The above review shows that the key gap in past ethno-ecology research is the absence of IK promotion for better use in development, protection and conservation of indigenous materials and practices. Past research provides ample evidence on the role IK in contributing to livelihoods, increasing productivity (crop, soil and water), reduction of environmental degradation (loss of nutrients, bio-diversity, and soils). However, research evidence on the role of indigenous knowledge systems in sustaining ecosystem services, contributing to carbon sequestration and climate change adaptation is still missing.

## 2. Methodology and study area

### 2.1 *The study area*

The study area, Damot-Sore, is one of the 13 districts in Wolayta Zone (Central Statistics Authority [CSA], 2009; 24-26). It is situated in the Southern Nation Nationalities and Peoples' Region [SNNPR] in Ethiopia at 06° 91' 92.9'' and 07° 19' 21.6'' North latitude and 37° 43' 73.9'' and 37° 84' 77.2'' East longitude (Figure 1). It is located Southwest of Addis Abeba at 336 km on the way to Hossaina main road. The district has a total of 0.11 million people (50% are women) and the inhabitants are identified as Wolayta (it means mixed people) ethnic group. The district capital, Gununo, is located 33 km away from Sodo Town**.** The altitude of the district varies from 1900 to 2010 meters above sea level [m a.s.l.] with average annual temperature of 22.5°C and the rainfall is 1250 mm/yr. Agro-ecologically, the district has 74% *weyna dega* (warm to cool semi-humid**)**, 15% *dega* (cool to cold humid**)** and 11 % *kolla* (semi-arid). Agriculture is the main economic activity although there are petty trades as subsidiary activity.

### 2.2 *Methodology*

This study uses an ethno-ecological approach as described in Rist and Dahdouh-Guebas (2006: 475) to examine the role of indigenous land management practices. General methods used for this study are stated in Walker and Sincair (1998: 366-380), Warren and Rajasekaran (1993: 8-10), Ajibade (2003: 100-102) & IIRR (1996: 20-30). However, specific methods applied involves the use of 40 key informants identified by elders, administrators and agriculture office staff in a sample of six Kebele Associations [KA]. Informants consist of 15% women and age class mix of 25% young (20-30 years), 25% mid-aged (30-50 years) and 50% old aged (50-90 years). Key informants were identified based on residence history, ownership of diverse of land management practices, agricultural knowledge and social acceptance. Information from key informants enabled describing land management practices and tabulating terminologies used for three major Land Use Types [LUT] (forest lands, croplands and grasslands) as categorized by (World Overview of Conservation Approaches and Technologies [WOCAT], 2008: 8). The procedures of data collection using key informants are similar as described in Joshi *et al.* (2004: 4). The selected KAs are Bolola ChawuSore, Sore Mashedo, Doge Mashido, Sore Wamura, DageAn Chocho, SoreKelena. A village dialogue approach was used to extract indigenous knowledge from folktales as described in Ajibade (2003: 102). Successive group interviews, discussions and validation sessions were held in all six KAs with an average attendance of twelve community members involving elders, men, women and youth at each site. The roles of identified nine indigenous land management practices were rated by experts at three scales (very high, medium and low) as indicated in Liniger and Critchley (2007). Ratings of soil-based ecological functions were based on a framework described by De Groot *et al.* (2002: 394). Expert rating was followed by community validation. Open-ended questions were used during group discussions to compare indigenous and conventional land suitability classifications (United States Department of Agriculture [USDA] and FAO methods) based on classification structure, features of land category units description and indicators.

 

## 3. Results and Discussions

### 3.1 *Indigenous land management in Damote-Sore District*

Examining the terminology in indigenous land management also reflects the wealth of people's perception and understanding (Table 1). Indigenous terminology reflects the type of land use, the state of land degradation, as well as mis-managed land. In this paper, land used for mixed agricultural land use, such as indigenous agro-forestry, was considered as cropland use. Indigenous agro-forestry is called as "Dgarso Bita", "EspeGosha" , "Wala Gosha" or "DarenCha".

The inventory of indigenous land management practices in Damote-Sore district (Table 2) reflects the diversity of land management practices in the area. The indigenous terms used for a fertile and an infertile soil agrees with previous description of Pound and Jonfa (2005: 15).

### 3.2 *Indigenous land suitability classification*

Land evaluation is the assessment of land performance or potential for a particular purpose to assist land use management (Sojayya, 2005: 5, FAO/United Nations for Environmental Program [UNEP], 1999: 46). People recognize different types of natural resources as part of their ecosystem and indigenous classifications reflect indigenous perceptions on land potential use and variability (Herweg 2002: 679). In Wolayta, Pound and Jonfa (2005: 10-18) documented indigenous soil classification and land use patterns at homestead levels. In this study, indigenous and modern land use classifications were compared based on classification structures (class and sub class), features of land-use class and type of indicators. People use indigenous land suitability indicators for allocation of land for various purposes. Indicators for indigenous land use classification include: steepness of land (slope), color (fertility), relative location of land to residential are, and location.

According to indigenous land sustainability classifications, croplands are allocated close to residential areas, on level land usually with dark colored soils (high fertility). Grasslands are allocated at distant from residential areas, on level land with less dark or brown color (less fertile) and on communal lands. Grasslands are allocated close to residential areas in "less productive' (marginal) lands and usually on the edges of croplands. Forest lands are allocated along the edge of roads, on steep slopes further away from residential areas and in areas with flood problems.

Comparing with the FAO framework of land evaluation (land suitability classification) and USDA land capability classification, the indigenous method has classes corresponding with the major order and sub-order or major class and sub-class. In the study area, croplands are sub-classified in to three fertility categories as highly fertile "Arada", medium fertile "Gudwa" and infertile "Leda". Grasslands are sub-classified in to three pasture quality categories as very good pasture "KoruWa", medium quality pasture "Acha" and poor quality pasture "Bodla" or Bedla". Forest lands are sub-classified into three forest density categories as dense forest "Wora", medium dense forest "Dursa" and less dense forest "Polwa".

Unlike the scientific classification, indigenous classification shows change in indicators depending on prevailing socio-economic conditions. Key factors inhibiting the use of indigenous classification over the past decades are increase in population density and land scarcity. Half a century ago, when population density was lower, grasslands were located far from residential areas. Today, however, the communal grasslands are being converted to either forest lands or croplands. Local peoples' insights, perceptions, and management strategies can offer guidance for realistic land management, as indicated by Sojayya (2005: 18), however, current land use management does not consider the existence of indigenous land-use classification.

### 3.3 *Indigenous cropland management in Damote-Sore*

#### *3.3.1 Indigenous crop residue and manure management*

Crop residues are deliberately left by farmers on cropland to increase soil fertility. Farmers say the residues decompose as termites use them, and this keeps the soil moist and covers it from direct sunlight, raindrops and wind. Crop residue is used in the area by different parts of the community (from rich to poor farmer). As cited by Pound and Jonfa (2005: 17), Elias (1997) found that 50 % of the farmers use crop residues in Wolayta. Crop residues from *enset*, root crops (potato, sweet potato) are often left at backyards, while crop residues from cereals (maize, wheat, *teff*), pulses (haricot bean) and leftovers from cash crops are left to improve soil health at distant fields. Traditionally, people do not allow livestock to graze on cropland after harvest, to avoid soil compaction and ensure crop residue incorporation into the soil. In a previous study in the area, the grazing practice was described as in-situ grazing (Pound and Jonfa, 2005: 19). Today, due to livestock pressure, scarcity of land and forage, livestock are allowed to graze on cropland after harvest to feed on left over crop residues.

The use of mulch "KaMiYoga" or "Bita MaZiYoGa" involves the use of leftovers from crop residues (leftover from animal feeds and crop residue). As cited by Pound and Jonfa (2005: 17), Elias (1997) found that 36 % of the farmers in Wolayta use mulch. The cover from mulch ensures moisture conservation and its decomposition contributes to soil fertility. Farmers clearly indicate the role of mulch in terms of turning soil color to darker color, increasing soil moisture and contributing to crop drought tolerance. The degree of mulch use is higher in fields close to homestead and those furthermost. Mulching is still a widely used practice in Damote-Sore, although in recent years the demand for fuel, house construction and animal feed has affected its use. In a previous study in Wolayta, Pound and Jonfa (2005: 17) documented the use of early maturing crops (crop selection) by farmers in response to drought and decline in soil fertility in the area.

The use of animal dung, ash and household trash on croplands is a common practice to improve soil fertility. In a previous study, composting was described as modern practice (Pound and Jonfa, 2005: 19). In the study area, manuring is well practiced with high concentration of manure at the backyards and that agrees with previous description of manuring practice around the homesteads (Herweg, 2002: 680). As cited by Pound and Jonfa (2005: 17), Elias (1997) found that 87 % of the farmers in Wolayta use manure. Addtion of soil organic ammedment ( manure) leads to carbon sequestration of 0.1 to 0.6 tons of C/ha/yr (Chan, *et al*, 2010;12).

On croplands, the role of inputs to soil (manure, mulch and crop residue) is reflected as an increase in productive soil ecological function leading to supply of nutrients and availability of air and water associated with an increase in soil organic matter (carbon). FAO (2001; 24-25) describe role of the above practice in improving soil and sequestering carbon. Estimate of carbon sequestration potential of various crop lands under different management varies from 0.1 to 0.8 tons of C/ha/yr (Liniger *et al*., 2011: 142) and from 0.02 to 0.76 C/ha/yr (Lal, 2004: 14). Chan *et al*. (2009: 6) reviewed croplands carbon sequestration rates from 0.1 to 0.6 tons of C/ha/yr with organic amendment (animal manure) . The soil ecological supportive and productive functions improved through nutrient cycling and increased crop yield, respectively. The soil ecological regulative functions are in reducing flooding and water stress. The overall role of these indigenous practices is reflected in reduced effect of drought, increased soil moisture and improved soil nutrients.

*3.3.2 Indigenous Cropping Practices*

*Enset* (*Ensete ventricosum*) seedling propagation is an indigenous practice. *Enset* is endemic to Ethiopia and occurs throughout the country both as wild and cultivated crop at altitudes ranging between 1,000 and to 3,000 meters (PGRC, 1995; 16). It is an important staple food for Wolayta people and preferred by most for being drought tolerant and a source of food and feed (Fekadu, 2009). The indigenous practice of seedling propagation (budding) from the mother plant involves cutting into pieces and burying the cuttings (covered with dung). A buried cut (often done in January) at a place can produce 20-40 seedlings in 2 months.

Multiple or inter-cropping is an indigenous practice on croplands. Farmers in Damote-Sore traditionally allocate a piece of land for multiple cropping in a season. Multiple cropping occurs with no or minimum competition for light, water and nutrient. Multiple cropping enables farmers to get a harvest at different times of a year and to minimize ecological risk from insect pest, disease or drought. Intercropping, locally described as “DuBer KeWo” is another age-old practice. Pound and Jonfa (2005: 22) have described it as rotation with legume. It has importance in terms of soil fertility improvement, increasing yield and ensuring income in time of disaster. The practice is widely used and practiced by growing of maize with potato or cabbage, beans (haricot bean or pea) with cereals (maize).

Farmers also undertake crop rotation, because they see a difference between crops in terms of improving soil fertility. For example, the role of haricot beans in improving soil fertility is well understood by 80% farmers in the area. A plot covered by maize in one seasons is to be covered by potato at another season. In crop rotation, potato can be followed by *teff* or Haricot bean. Such cropping practice has been indicated by Herweg (2002: 680) as local knowledge based on soil-plant-fauna relationships involving selection of crops for sustainable soil use. Improved crop rotation on crop land leads to carbon sequestration of 0.1 to 0.3 tons of C/ha/yr (Chan, *et al*, 2010;12).

The role of indigenous cropping practices increases the productive ecological functions, as it leads to better supply of food and fiber. The ecological supportive functions are in improving nutrient cycling from various combinations of plants in time and space. The ecological regulative functions are in reducing the effects of drought, sequestering carbon and reducing water stress. The practices contribute to overall ecosystem management and climate change adaptations.

*3.3.3 Indigenous agroforestry and cultivation methods*

Indigenous agro-forestry practices at homesteads are described as “Wolay Gosha” (see Table 1). Land holding for agro forestry at homesteads usually varies from 0.5-0.25 ha with various crops (cereals, pulses, spices and fruits) and different combinations of trees species. Farmers describe the importance of indigenous trees as a source of food, moisture, animal feed and shade. It is widely practiced in the study area; however, wealth status of the farmer seems to have an effect on agro-forestry practices in terms of the land holding, density and diversity of trees and crops.

Indigenous agro-forestry has a role in increasing productive ecological functions as it diversifies food supply throughout the year. It reduces the effects of drought and famine, and it plays a significant role in climate change mitigation and adaptation. The supportive functions of the practice include improving nutrient and water cycling from a combination of crops and trees of different layers. The regulative functions are in reducing flood problems, regulating microclimate, sequestering carbon (above and below the ground), and in reducing evaporation (water stress. For wide ranges of indigenous agroforestry practices the estimate of carbon sequestration potential varies from 0.3 to 6.5 tonnes C/ha/yr (Liniger, *et al.*, 2011: 126), while estimates by Lal (2004: 13) are lower with values ranging from 0.8 to 1.0 tonnes C/ha/yr. The role of indigenous agro-forestry extends to contributing to strong cultural values through growing of culturally preferred crops, increasing homesteads aesthetic value though improvement of landscape beauty.

There are also other indigenous cultivation methods where farmers plow along the contour, construct ditches to divert excess water, and harvest water. There are two indigenous tillage equipment used by Wolayta people. The first is a smaller hoe called "TikiYa" (Figure 2/picture a). It is smaller in size with two sharp pointers used for weeding of shallow rooted plants and to work on light soil. The second is a bigger hoe called "AyLiYa" or "Wolayta Hoe" (Figure 2/ picture b). It is used to till virgin land, work on deep-rooted plants and heavy soil. The hoes are used to till hilly areas where oxen cannot be used. As described by Kolawole (2001: 4) indigenous technical knowledge [ITK] has inherent features of construction material as described by local people. In the past, the tillage equipment used to be made from wood and rope but in recent years, it is made from wood and metal.

### 3.4 *Indigenous grass and forest land management*

Indigenous practices on grasslands in the study area include enclosure, grassland burning, rotational-grazing and grass land enrichment. Regeneration of degraded grassland is often done through enclosure at household level. Forage is more valued by farmers than the grassland. Farmers describe the improvement of grass growth, reduction of soil erosion and improvement in soil fertility with grassland enclosure. This is widely practiced in private grasslands and at homesteads. Indigenous practice of cut and carry system "Korawo" is used with enclosures. The indigenous practices contribute to the carbon reserve on grassland as reviewed in FAO (2001: 7). Estimates of the carbon sequestration potential of enclosure areas with various vegetation vary from 0.1 to 3.0 tons of C/ha/yr (Liniger *et al*.,2011:142) and for grass lands from 0.02 to 1.3 tons of C/ha/yr (Lal, 2004:14) and with improved management from 0.1 to 0.5 tons of C/ha/yr. (Lal, 2004:14). Chan *et al*. (2009: 6) reviewed pasture lands' carbon sequestration rate to be from 0.1 to 0.7 tons of C/ha/yr according to various management practices.

Another indigenous practice is grassland burning, locally called as "TaraGa TaMa YoDeSoNa" or "MaTa Bi Ta TuGi Yo Ga". The burning is undertaken in the dry season. Wall and Kanawha (2001: 36) have described importance of indigenous burning; the community also points at the benefits of burning in promoting fast growth, and improving grassland ecology. Potential carbon sequestration of grass lands with fire management varies from 0.5-1.4 C/ha/yr (Lal, 2004:14), but the overall potential of various grasslands under different management varies from 0.1 to 0.3 tons of C/ha/yr (Liniger *et al*., 2011: 156, Lal, 2004:13)

Rotational grazing (controlled grazing) is also practiced instead of free grazing to overcome the problem of overgrazing and increase pastureland productivity. Most farmers (70%) do not associate the benefit of this practice with land. Scarcity of pastureland has restricted the use of this practice. In a few localities including homesteads, zero grazing and cut and carry systems are used today.

Communal grasslands are enriched through grass multiplication. The most common method of grass multiplication is to let the grass grow to climax, so that the seeds are dispersed on the land. Grass is mowed after ensuring seed scattering. Shrubs are cleared and uprooted from grasslands, for easy movement of animals. There is also a deliberate removal of unpalatable species and damaged grass on grassland. The community has indigenous by-laws to reduce mismanagement; however, due to a lack of law enforcement, the grasslands are mismanaged and overgrazed.

The potential of forest ecosystems and their role in carbon sequestration is well documented (FAO, 2001: 6). Traditionally, people take care of trees on their land and at farm boundaries. There are communal by laws for forest land. People value and take care of forest products rather than the of forest soils. On forest lands, there are two methods of forest harvesting methods "complete clearance" and "selective clearance". The harvesting practices make use of indigenous indicators for cutting matured trees. Harvesting time is determined as most trees reach their climax, which is determined using indigenous indicators: tree height, leave and stem color, stem width and branching. Fully grown trees in climax vegetation usually change color of leaves and stem as key local indicators.

There is an indigenous method of burning tree stems cuttings (stump) also called as "TeReGa". Stumps are burnt slightly in a controlled way so that tree stems can grow fast. This method is often used today with exotic trees like *eucalyptus*. Burning stumps, on the one hand, promotes the emergence of buds, and it fastens tree growth. On the other hand, it clears weed from the woodlot and contributes ash to the soil. Burning shortens the coppicing cycle. Burning of stumps can lead to accelerated rainfall erosion, if undertaken in hilly area. This method is associated with coppicing as a traditional method of woodland management.

There are indigenous methods of growing tree seedlings (from seeds, buds and from seedling). FAO (2005: 9) describes common knowledge as held by all people, shared knowledge by many and specialized knowledge by few people. Some of the techniques of growing seedlings are based on specialized knowledge and are known by few people in the area. Collecting young seedlings in undergrowth and transplanting is one method. Another method is collecting tree seeds and buds and bury (by covering with dung). Approximately a tree bud buried at a place can produce 20-40 seedlings in 2 months. This is often done at the beginning of the rainy season.

*3.5 Role of indigenous land management practices*

There are indigenous land management practices, which lead to an improvement of soil-based ecological functions and to sequestration of carbon. There is diversity among the nine indigenous land management practices and spatial variability of each practice among farmers in the area (Table 2). Thus, the role of each practice to sequester carbon (quantity and type of carbon), contribute to climate change adaptation and sustain soil-based ecosystem services varies. In spite of the variation in the role of the practices, experts' ratings were followed by community validation. Expert rating involved ranking the role of each practice based on three impact scales rated as very high, medium and low (Table 3). Indigenous technologies are developed by the local community to solve a particular problem (Ajibade 2003: 100). The indigenous practices address one or more problems envisaged in the community. On the basis of inventory of nine major practices, this study shows that indigenous agro forestry is the best to address multiple problems envisaged by the community. It has the highest potential in sequestering carbon (both above and below ground) per unit of land, to improve soil ecological functions, and to contribute to climate change mitigation and adaptation.

*3.6 Indigenous knowledge system transfer*

Indeed, many indigenous conservation practices are linked with ancient people's perspectives and practices and their relationship with the ecosystem (Mathiui and Kariuki, 2007: 536). IK is embedded in community practices, institutions, relationships and rituals (FAO 2005: 7), which reflect people's relation with the ecosystem. Wolayta people have lived in close to their natural resources. The Wolayta values and perspectives are also reflected in indigenous proverbs (Table 4), which depicts that people are part of the ecosystem, and these restrict peoples' right to over-exploit natural resources. The Wolayta perspective of a "nature-human" relationship is also reflected on nature regeneration capacity and man's responsibility to maintain harmony with nature. People in the study area believe that nature can restore itself and God locally called as "Toso" enables natural resources re-generation. The Wolayta ecosystem value contributes to co-existence and sustainability of ecosystem. Elders describe degradation of ecosystems (soil, vegetation, water) as a wrong practice and Wolayta cultural ceremonies are much liked with maintaining a well-managed ecosystem. The socialization of people in meeting places called "Gutara" reflects the link between well-managed ecosystems and culture. "Gutara" has dense green tree shades with good pasture as undergrowth, which is also used during "funeral ceremony" and horse galloping. IK is transferred from one generation to another through indigenous communication channels (Dixon, 2002: 6). IK tends to be communicated through daily routine activities, storytelling, village meetings, drama and in many other ways. IK information can also be extracted from traditional folktales as described in Ajibade (2003: 102) from one generation to another in the form of stories, tales or proverbs. African indigenous traditions contain symbolic and ethical messages and are passed on to ensure respect and compassion for parts of ecosystem (Kelbessa, 2005: 17), as stated in selected proverbs "Hayise" in Wolayta (Table 4).

In South Western Ethiopia, Dixon (2002: 42) found ancestral knowledge as important source of information. In Damote-Sore District, indigenous practices are valued as ancestral knowledge and are also used by the present generation. There are IK practices which have strong similarity with some selected introduced practices. Examining the relationship between IK and introduced practices shows that IK has contributed to the introduction and later adoption of introduced practices like enclosure, cut and carry, intercropping, and afforestation. The contribution lies on the association between introduced practices with prior knowledge of farmers' practices. Today, farmers make use of indigenous knowledge systems along with introduced land management practices. This also shows the role of IK in current natural resource management, yet the effort to integrate with current development is not in place. Indigenous land management knowledge is overlooked, as there is neither effort to show its weakness nor its strength by relating it with modern land management practices. The use of indigenous knowledge is, however, restricted by socio-economic factors (land scarcity, high population pressure resulting in expansion of crop land). This restriction shows the less contribution of IK in present day ecosystem management, compared with the expected role. Some of the abandoned indigenous land management practices in the area in recent days include: grassland burning, fallowing and reduction in amount of crop residue left on croplands.

## 4. Conclusions and Recommendations

Indigenous knowledge systems have contributed to the maintenance of the present day, diverse and rich bio-diversity among the Wolayta ethnic groups under different agro-ecosystems against the historical social and natural problems in the area. This has been reflected in Wolayta values and perspectives for the ecosystem and in the indigenous proverbs.

Ethno-ecology research in Ethiopia has shown the importance of IK since the 1980s; however, efforts to integrate them with development have lagged behind. Past research shows the role of IK in reducing erosion, increasing soil fertility and crop yield to the extent of contributing to people's livelihoods. Past studies; however, do not show spatial variation of practices and the role of IK in sustaining ecosystem services and contributing to carbon sequestration. It is recommended that studies be conducted on the spatial variation of indigenous practices, their transfer, promotion and integration of IK systems for better economic use at a larger scale.

Based on similarity and association between some introduced and indigenous practices, this study reflects the role of IK in ecosystem management and its contribution to adoption of introduced technologies. The wealth of indigenous practices in land management in Damote-Sore is reflected in the diversity of practices, terminology used and indigenous land-use classification system applied. The reduced role of IK system in enhancing soil based ecosystem services is associated with the prevailing socio-economic factors, which hinder the use of this knowledge.

Croplands have more diverse and widely used indigenous practices than forest lands and grasslands. The inventory and rating of nine major land management practices shows that indigenous agro-forestry has the best rating, as it provides multiple benefits in sustaining ecosystem services while sequestering carbon in above and below ground and contributing to climate change mitigation and adaptation. The study recommends that further quantitative validation of indigenous practices in terms of carbon sequestration and ecosystem valuation be done in the study area.

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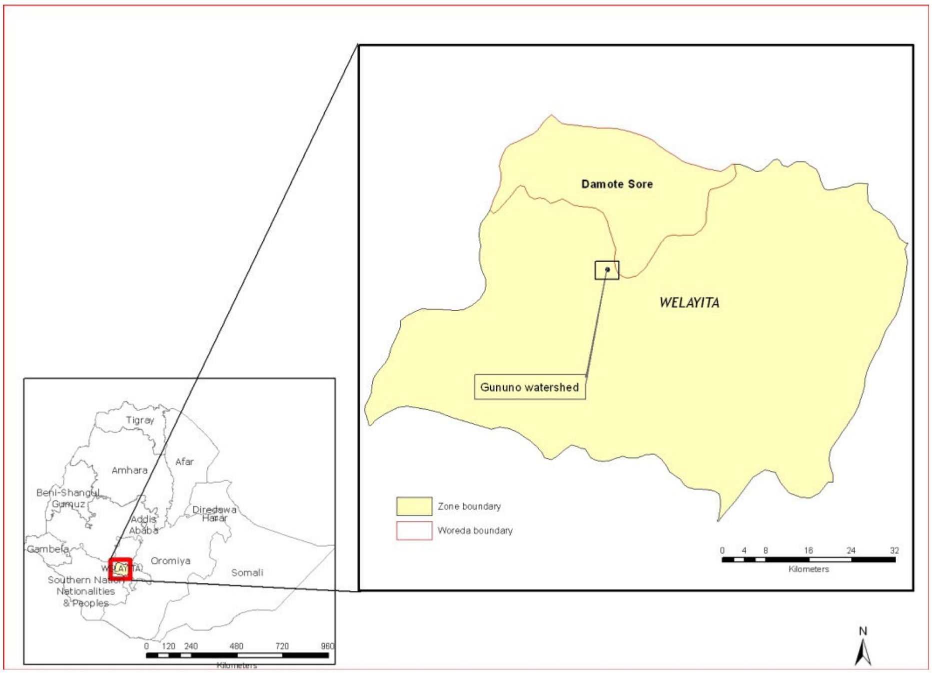


Figure -1-Location of Damote-Sore District (Wolayta Zone), Southern Ethiopia

| | |
|---|---|
|  |  |
| TikiYa (a) | AyLiYa (b) |

Figure -2-Indigenious tillage equipment in Damote-Sore District (Wolayta)

Table -1- Indigenous terminology in land management in Damote-Sore (Wolayta)

| LAND USE | Land use type | Mismanaged | Well-managed |
| --- | --- | --- | --- |
| Forest land | "Mita Bita(Gade)", "Wora", "Wora Bita" refers to land allocated for trees | "Leda Bita" Infertile land<br>"Mita KenTicheS" or "WoraKta" = forest clearance/deforestaion<br>"Ma lele KanT Yoga" = forest clearance | "Arada-Bita" = fertile land |
| Grass land | "Mata Gadiy" or<br>"Mata Bita (Gade) or "Denba"= refers to land where grass grow and animals graze | "Korawo Bita" Infertile land<br>"Bodla Bita" or "KoTeda Mata Bita" overgrazed land or mismanaged pasture<br>"BulaYis" = overgrazing<br>"Wudro HamiYoga" = using grass land beyond its carrying capacity | "KorWa"= good pasture land |
| Crop land | "Gosha Bita (Gade) or "Kata Gadiy", = refers to land allocated for annual crops | "Leda Bita" = Infertile land, Unproductive land<br>"LadSiS" or "AtiSis" = infertile soil<br>"KaTa Wose" or "Loyit Aykibena" = poorly managed crops<br>"Harum Tibenaga"=poorly weeded crop land<br>'OstBena Kata" or 'Lo hi Ahe TiBena" = mismanaged cropland/ infertile | "Arada-Bita" = fertile land |

**Source:** group discussion and key informants

Table -2- Indigenous land management practices in Damote-Sore

| No | Wolayta (local) name | Amharic name/Connotation | English name | Land Use |
| --- | --- | --- | --- | --- |
| 1 | "Osha Gade Kisde YoGeYoGa" | BisBash Mechemer | Manuring | Crop land |
| 2 | DuBer KeWo | Abro Mezerat | Intercropping | Cropland |
| 3 | "KaMiYoga" or "Bita MaZiYoGa" | Meret Meshefene/Malbese | Mulching | Cropland |
| 4 | "Dgarso Bita", "EspeGosha" , "Wala Gosha"or " DarenCha" | Timir Ersha | Agroforestry | Cropland with trees |
| 5 | "TeReGa". | Guto Makatel | Burning of tree stem cuttings | Forest land |
| 6 | "Sufe (Burche) Bitata Mata GarsaFe KetiYoGa" | Enchet Ke Sar Koreta | Enrichment (removal of unpalatable species) | Grassland |
| 7 | "DirSa" | MaTer/MeKelel | Enclosure | Grassland |
| 8 | " Korawo" | Achido Memegeb | Cut and Carry | Grassland |
| 9 | "TaraGa TaMa YoDeSoNa" or "MaTa Bi Ta TuGi Yo Ga". | MaKaTel | Burning | Grassland |

Source: community discussion and key informants

Table -3- Expert rating of indigenous land management practices

| No | Wolayta (local) name | Amharic name | English name | Carbon Sequestration | | Impact | |
|---|---|---|---|---|---|---|---|
| | | | | t C/ha/yr | Impact | Soil-based | Climate Change |
| **1** | "Osha Gade Kisde YoGeYoGa" | BisBash Mechemer | Manuring | 0.02-0.7*<br>0.1-0.8[#]<br>0.1-0.6" | +++ | +++ | + |
| **2** | "DuBer KeWo" | Abro Mezerat | Intercropping | 0.02-0.7*<br>0.1-0.8[#]<br>0.1-0.3" | + | ++ | +++ |
| **3** | "KaMiYoga" or "Bita MaZiYoGa" | Meret Meshefene/Malbese | Mulching | 0.02-0.7*<br>0.1-0.8[#] | + | ++ | +++ |
| **4** | "TeReGa". | Guto Makatel | Burning tree stem cuttings | NA | + | + | ++ |
| **5** | "Sufe (Burche) Bitata Mata GarsaFe KetiYoGa" | Enchet Ke Sar Koreta | Enrichment (removal of unpalatable species) | 0.1-0.5*<br>0.1-0.3[#] | + | ++ | + |
| **6** | "Dgarso Bita", "EspeGosha", "Wala Gosha"or "DarenCha" | Timir Ersha | Agroforestry | 0.8-1.0*<br>0.3- 3.6[#] | +++ | +++ | +++ |
| **7** | "DirSa" | MaTer/ MeKelel | Enclosure | 0.1-3[#]<br>0.02-1.3* | ++ | ++ | + |
| **8** | " Korawo" | Achido Memegeb | Cut and Carry | 0.1-3[#]<br>0.1-0.5* | + | ++ | + |
| **9** | "TaraGa TaMa YoDeSoNa" or "MaTa Bi Ta TuGi Yo Ga". | Sar MaKaTel | Grass land Burning | 0.5-1.4*<br>0.1-0.3[#] | + | ++ | + |

**Source:** Expert rating and community validation [#] Liniger, *et al.* (2011) is based on expert estimates for various activities. *Lal (2004) "Chan, *et al*, 2010

**Impact rating:** +++ = very high; ++ = medium; + = low, and NA. = not available

 

**Table -4 – Selected proverbs on role of indigenous land management in Damote-Sore District.**

| *Wolaytigna* | *Amarigna* | *English translation and connotation* |
|---|---|---|
| "AyeFud Gedis Akid Gedena" | "Masan masfat SayHone Bicha, Masan menKebakeb Mertin Yasadigal" | It is not land expansion alone that increases yield, but also taking care of the land.(Implying the role of using intensive management, e.g. mulch, manure, etc. to increase productivity of land) |
| „Bitaw TaleDaYe, GaMa MeTet EreNa" | "Le Meret YaBeDere WeYniM YeseTe, WaNa Wun Aybelam" | Whoever loans or provides to a land, never gets bankrupt. (Implying the role of leaving crop residue, adding materials to the soil in return of the final benefit in terms of yield/harvest.) |
| "MiZaYaYi EsESan AeKeAGed, BiTaMo Gadiyo YoShaDa Hemik" | „KeBeTe BeAnde Bota AfeRi Yigital, SeleZhi ZerZer Aderge Aged" | If you let cattle graze at a spot, they graze bare land, so you let them graze in a controlled way. (Implying the danger of overgrazing and importance of controlled grazing.) |
| "SanTan SanTed LokoMan GaKoSe"<br>"LokoMan Lokomed Badla GaKose" | "BeGoMen Tedegefen Adenguare Indersalen, Adenguare Tedegefen Bokolo Endersalen" | Because of having cabbage, we reach for Haricot Beans. Because of having haricot bean we reach for Maize. (Reflecting the role of cropping practice, e.g. inter cropping/crop rotation as peoples livelihood strategy.) |
| „Atena Kat MaTa, AareNa NaEi TaLeHe" | "YaLeTeKoTeKoTe Sebel Arem New, aLeTeKoNeTeTe LiJi SeTaN New" | If a crop is not cultivated, it is a weed. Likewise, if a child is not disciplined, it is like Satan. (Implying the importance of weeding or cultivation in land stewardship.) |
| "Bete Asa" | "Bezu YemYiKoyi Sew" | One who does not inhabit long in an area. (Being a term used by farmers, for those who lack backyard tree shade, reflecting the importance of indigenous agro-forestry.) |

**Source:** Community discussion