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Farmers Soil Management Practices and Their Perceptions to Soil Acidity at Ankesha District of Awi Zone, Northwestern Ethiopia

[1]Tessema Genanew, [2]Mekuria Argaw and [3]Enyew Adgo

[1]Department of Soil and Water Resource Management, Wollo University, Ethiopia
[2]Environmental Science Program, Science Faculty, Addis Ababa University, Ethiopia
[3]Department of Natural Resource Management, Bahir Dar University, Ethiopia

Abstract: Soil acidity is a critical issue requiring urgent attention in Northwestern highlands of Ethiopia due to its impact on crop production and soil productivity. The objectives of this study were to understand the farmers soil management practices as well as their perceptions on soil acidity problem in Ankesha District. Socioeconomic survey using structured questionnaire and several PRA techniques were employed in order to understand farmers' perception on soil acidity problem and their coping mechanisms. Results revealed that farmers are well aware of the soil acidity problem. Plots exhibit such problem known as '*Gibiz Merate'*; meaning, land poorly responsive to farm inputs. Farmers' understanding of soil acidity problem is based on several indicators including workability, yield decline and appearance of weed species. Soil acidity is perceived to occur when parent material is acidic, rainfall is high, erosion is intensive and the land is continuously cultivated. Thus, their action to cope up with the problem focused on use of farmyard manure around the homestead garden, shift the cropland to Eucalyptus plantation or for grazing. The study underscores that soil acidity problem is critical in Ankesha District of Awi zone and calls the need for immediate intervention to amend the soil for crop production. Hence, researchers and policy makers should give due consideration for public/farmers awareness creation on acid soil management and improvements on land management practices for sustainable productivity of soils.

Key words: Ankesha District · Management practices · Perception · Soil acidity

INTRODUCTION

In most parts of the country, the dependency on farming is extremely high, with 90% of the population being entirely dependent on agriculture. However, farm productivity is low as the result of lack of agricultural inputs, outdated farming methods, widespread land degradation, overgrazing, soil erosion, uncertain land tenure and recurrent droughts, all in combination with high population pressure [1]. In the highlands, due to intensive land use and high population pressure, the land is severely degraded, eroded and the nutrient status of most soils is decreasing. Between 70 and 75% of the agricultural soils of the highland plateau area of Ethiopia are phosphorus deficient [2]. Animal manure and crop residues, instead of being returned to the land, are largely used as fuel and livestock feed respectively [3]. Continuous cultivation and inorganic fertilizer application resulted in decline of soil pH and caused loss in basic cations especially under intensive cropping on inherently poor soils [4].

Currently research attention has been renewed interests in soil acidity because of its impact agricultural productivity and production. In tropical regions, soil acidity is a major problem, which can have pedogenic or anthropogenic causes. The upland soils are nevertheless considered the largest remaining potential for future agricultural development [5]. The western and southern parts of Ethiopia, are dominantly covered by soils with pH<5.5 [6]. As stated by Abdenna *et al*. [7] the acidity problem in East and West Wellega zones of Ethiopia is serious. Particularly, the highly weathered and leached Acrisols of Injibara area (Awi Zone) have strong acid reaction (4.81) [8].

Corresponding Auther: Tessema Genanew, Department of Soil and Water Resource Management, P.O. Box-11 45, Wollo University, Ethiopia.

The scope of soil acidity and rates of acidification are receiving interest in Awi zone. The perception of farmers on the effect of land use type and management practices on soil fertility parameters in Awi zone is very limited. As the result of this knowledge gap, farmers remain with one or two relatively acid tolerant crops to sustain their life. Yield reduction problem is continuing. The reasons for the yield reduction associated with soil acidity and management practices that help to overcome soil acidity and/or aggravate acidity problems are not clearly identified and described. Farmers and development agents did not know of the existence of acidic soil in the area until recently. Therefore, the objectives of this study were to understand the farmers' soil management practices as well as their perceptions of the problem in order to put forward possible soil management options to minimize soil acidification in the Ankesha area.

MATERIALS AND METHODS

Description of Study Area: The study was conducted at Ankesha district of Awi Zone, which is located in the Amhara Region of Northwestern Ethiopia (Fig.1). It lies within latitudes 10°23'N and 10° 85'N and longitudes 36°35'E and 36°57'E [9]. The altitude ranges between 1000 and 2800 m.a.s.l. Undulating slope, seasonal and intermittent streams and steep slopes are characteristics of the topography of the site.

The study area receives erratic rainfall with mean annual value of 2057.5 mm [10]. The months of July and August receive the highest amount of rainfall that reaches above 450mm per month at the peak periods. Temperature varies between the mean annual minimum of 11°C and mean annual maximum of 25°C across the elevation gradient [10]. The *Woreda (i.e.* district) spans three agro-climatic zones; Dega (highlands) (10%), Woina Dega (intermediate) (80%) and Kolla (lowland) (10%) [11]. The study was focused in the highland part where soil acidity is critical.

The soils of the Northwestern highlands of the country are largely developed from parent materials of volcanic origin. However, in certain parts, there are soils that were developed from basement materials, limestone, alluvial materials and sandstone [12]. The soils of the area are closely related to their parent materials and their degree of weathering. The main parent materials are basalt, granite, gneiss, volcanic ash and pumice while granite rocks (i.e. trachyte and rhyolites) are acidic than the plateau basalts [13]. The dominant soils in the Amhara National Regional State in their respective order are Luvisol (15.1%), Cambisols (14.3%), Leptosols (14.3%), Nitosols (13.7%), Vertisol (10.8%), Acrisols (2.6%) and Regosols (2.1%) [14] (Bureau of Agriculture, 1999). The soil of Injibara (study site) belongs to Acrisols [8].

At present, cultivated lands cover about 77%, vegetation constitutes 13.2% and grazing land is limited to 7.85% whereas infrastructures and others constitute 2.22% of the geographical area [11]. The farming system of the area is predominantly subsistence farming based on mixed crop-livestock production. Major crops grown in the area are maize, tef, potato, wheat, barley and other vegetables, mainly with one harvest per year. In addition, barley, wheat, potatoes and other vegetables are also produced twice per year with traditional irrigation system.

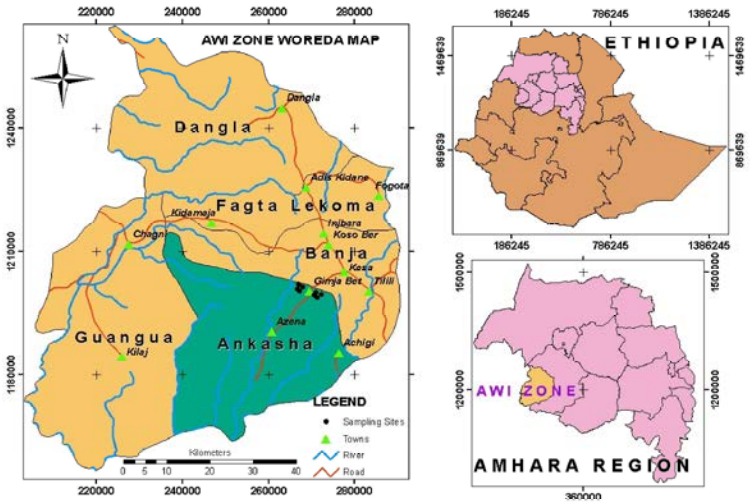

Fig.1: Map and location of the study area in Amhara National Regional State
Source: Gis by ESRI (2005)

MATERIALS AND METHOD

Socioeconomic Survey: Socioeconomic survey using structured questionnaire and several PRA techniques were employed in order to understand farmers' perception on soil acidity problem and their coping mechanisms. Open and closed ended semi structured questionnaires were prepared to substantiate and augment the qualitative results. The procedure of household selection was carried out as described below.

Household Selection: Firstly, a purposive, method was employed to identify representative peasant associations (PAs) from twenty-nine kebeles of Ankesha District. The sampling method was purposive because the selected farmer should know his land and crop behavior as well as management practices at least in ten years of experience in order to differentiate which crop was disappeared and which one has been newly introduced. Based on information collected from a reconnaissance survey, accordingly, Denzuria and Hateta peasant associations were selected. The reason why these two kebeles were chosen is that, they are representative of other ten kebeles that have soil acidity problems in the district. Their most agro ecological, biophysical, geological origin and the socio economic aspects of the area are more or less similar with other nearby kebeles (observation). Thus, they represent a good example for the perception analysis. Besides, there were no previous attempts of assessing any soil acidity causes, problems and coping mechanisms for acid soil. Secondly, sample households were purposively selected from a list of registered peasants obtained from the respective PAs administration offices based on criteria. The criteria includes those farmers whose age greater than 32 years. In the study area, a farmer assumed to be independent from his family when his age greater than 22. The study needs the farmers who have farmland management practices on own land at least 10 years. Therefore, farmers whose age greater or equal to 32 years may realize long-term history of the land use practices. The other criteria were proximity to the sampled site and land ownershipness.

Questionnaire Survey: The questionnaire was prepared in English. In order to facilitate the survey and to collect appropriate information, the questionnaire was translated into the local language (Amharic). After translation questionnaire was tested and reviewed. From the 1056 households in Hateta and 1332 Denzuria PAs, 60 farm households were selected for each kebele. Data on household characteristics, farm attributes or variables related with soil acidity and its management, characteristic and coping mechanisms of soil acidity, crop production systems, field history, eucalyptus plantation and grazing land management's aspects were collected by administering a semi-structured questionnaire survey. Informal discussion with elders and agricultural experts were also employed to understand the extent and severity of soil acidity problems in the study area.

Data Analysis and Statistical Procedures: The data generated by questionnaire survey was analyzed using descriptive statistics. Sample means and variations were calculated for attributes that are parametric and sample proportion was calculated for the attributes that are categorical. The qualitative data generated by semi-structured questionnaires and informal discussion with respect to land management practices were used to substantiate and augment the quantitative results. The data were edited, coded and analyzed using the Statistical Package for Social Sciences (SPSS) [15].

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Households: The majority (> 97%) of the surveyed households were male-headed and the mean age of respondents (household head) was 46 in the Hateta kebele and 49 in Denzuria kebele. Most of the respondents in Hateta kebele were literate either with formal or informal education and only 37% of them were illiterate. However, in Denzuria kebele, more than 42% of the respondents were illiterate. The average family sizes of the household were 6 and 7 in Hateta and Denzuria PAs respectively (Table 1). Beside, more than 95% respondents were married on both peasant associations (Table 1). Farmers in the Hateta kebele had a mean land holding of 1.625 ha per household. Whereas in Denzuria kebele Pas mean land holding is 1.575 ha. Furthermore, 92% in Hateta and 95% in Denzuria of the surveyed households have their own land (Table 1).These households obtained land through a system of land redistribution/land allotment. In spite of low farm productivity, all of the surveyed households are being entirely dependent on agriculture.

Perceived Causes and Indicators of Soil Acidification: Farmers in the study area have a wealth of knowledge about their land resources, its characteristics, limitations,

Table 1: Characteristics of respondents in Hateta and Denzuria kebeles

Peasant Association	Sex (%)		Average Age	Educational Status (%)		Average Family size	Marital status (%)		Average Land (ha)	Own Land (%)
	Male	Female		Literate	Illiterate		Married	Divorce		
Hateta PAS (n=60)	98	2	46	63	37	6	97	3	1.625	92
Denzuria PAS (n=60)	97	3	49	58	42	7	95	5	1.575	95

Source: survey data (2008)

Table 2: Perception of farmers on existence of soil acidity problem

Responses	Hateta Peasant Association		Denzuria Peasant Association	
	Frequency	Percent	Frequency	Percent
Yes	48	80.0	51	85.0
No	12	20.0	9	15.0
Total	60	100.0	60	100.0

Source: Own survey (2008)

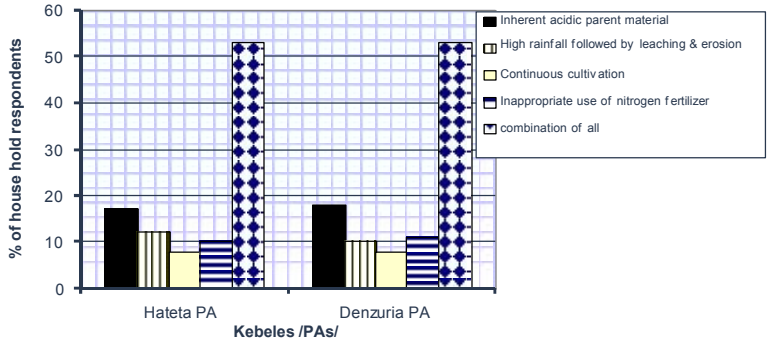

Fig. 2: Farmers' response for probable causes of soil acidity

potentials and management options. About 80% and 85% of surveyed households in Hateta and Denzuria PAs respectively, were aware of the existence of soil acidity problems (Table 2).

Their awareness may be due to the promotion activity of the government for lime application on farm demonstration trial. In fact, they didn't know the name "acidic soil" before the stated year but locally, they call such farmland "*Gibiz Merate*"; meaning 'poorly responsive to farm inputs'. They explained as, the name "Gibiz" is given to it due to lack of response for fertilizer and poor performance of the crop to be sown. These lands are not suitable for many crop except some grass species and relatively acid tolerant crops like, tef and potatoes. This is in agreement research findings who explained that acid soils frequently are 'inactive' with fertilization [6]. Farmers reported to have converted 'Gibiz land' to 'non Gibiz land' by frequent application of farmyard manure and using agronomic practices.

Farmers who assured soil acidity as a key problem were asked to list and rank the main causes of soil acidity. In both peasant associations, more than 51% of the surveyed households perceived that soil acidity is attributed to several factors including inherent acidic parent material (acid by nature), high rainfall followed by erosion and leaching, continuous cultivation and inappropriate use of nitrogenous fertilizers (Fig. 2).

The way that plants take up nutrients results in a partitioning of acidity into the soil and alkalinity into the plant as dry matter [16]. Agriculture removes plant material from the soil as grain or pasture, less alkalinity is returned to the soil and the soil becomes more acidic. Above 70% of the surveyed households used crop residues for livestock feed (Fig. 3). Similar results observed by other researcher [3]. He noted that in the highlands, animal manure and crop residues, instead of being returned to the land, are mainly used as fuel and livestock feed.

According to farmers' explanations, "Gibiz Merate'' has the following chacterstics and indicators:

- High workability in dry season /easy for ploughing/
- Low water holding capacity, high seepage
- Suitable for few grass and crop species, only tef and potatoes are grown
- The soil is reddish to black in color

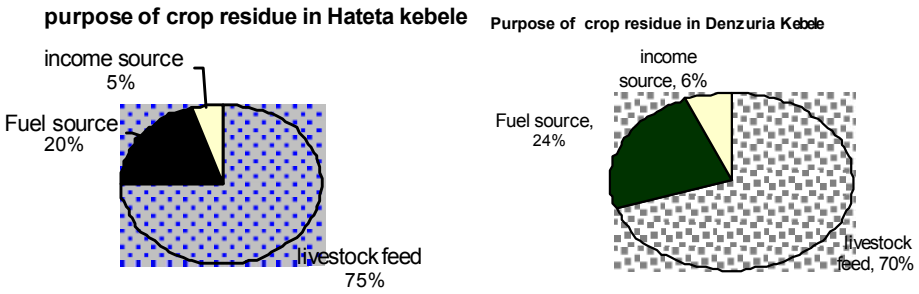

Fig. 3: Pie chart for response of farmers towards the use of crop residues (n=60)

Table 3: Farmers' perception for crop yield reduction (n=60)

	Hateta Peasant Association			Denzuria Peasant Association		
Yield Reduction Causes	Frequency	Percent	Cumulative Percent	Frequency	Percent	Cumulative Percent
Soil Acidity	27	45.0	45.0	30	50.0	50.0
Soil Erosion	26	43.3	88.3	23	38.3	88.3
Snow"berdo" and Pests	3.0	5.0	93.3	4.0	6.7	95.0
Idon't realize	4	6.7	100.00	3	5.0	100.0
Total	60	100.0		60	100.0	

Source: Own survey (2008)

Table 4: Comparison of crop yield in quintal per hectare /Qt/ha/ in 1980s and 2007

		Average yield Qt/ha in 1980s			Average yield Qt/ha in 2007				
S/No.	Crop type	Min.	Max.	Average	Min.	Max.	Average	Yield difference	% of yield Reduction
1	Tef	11	18	14.5	4	8	6	8.5	58
2	Barley	20	31	25.5	8	12	10	15.5	61
3	Noug	4	6	5	1	2	1.5	3.5	70
4	Linseed	3	4	3.5	*	*	*	-	100
5	Wheat	16	28	22	*	*	*	-	100
6	Potato	60	90	70	30	52	41	29	41
7	field pea	8	14	11	*	*	*	-	100
8	Field bean	9	15	12	*	*	*	-	100

(*) Indicate where the crop is not produced by now in the specified area, min. = Minimum, Max. = maximum. Source: Office of Agriculture and Rural Development (2008)

Symptoms Tend to Indicate Problem of 'Gibiz Merate' (Soil Acidity):

- Decline crop yields,
- Leaf discoloration and susceptible to stress
- Low response to fertilizers, reduced yields, poor plant vigor and increased incidence of disease
- Uneven pasture and crop growth
- poor establishment and persistence of pasture
- Poor nodulation of legumes, annual weeds infestation,' persistence of acid-tolerant weeds' such as locally called Arebakash (*Spergula arvensis*) and Yeweftef (*Eragrostis cilianensis)*

Crop yield Decline: Agricultural experts and farmers noted that crop production has been declining during the last fifteen years. About 88.3% of the surveyed households also perceived that soil acidity and soil erosion were the main reasons for crop yield decline (Table 3). Some of the crops such as field pea, field bean, wheat, linseed, barley and others become out of production due to soil acidity problems unless special management is employed.

The evidences from farmers and agricultural experts indicated that most crops have poor yield performance in acid soil. Some of the crops disappeared in the surrounding since two to three decades. Productivity, crop diversity and yield drastically had been reduced since the 1980s. For instance, legumes and wheat become out of production (Table 4). Even though new varieties were not introduced in the cropping system, the existing once like potatoes and tef relatively covers large proportion of the cultivated area by now (Table 4). As described in soil acidity management and lime application principle guideline, crops vary in their acid saturation tolerance limit. In comparisons, tef and

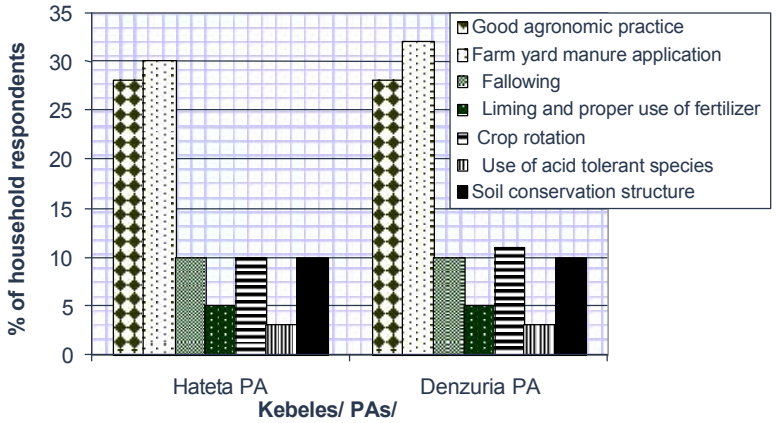

Fig. 4: Farmers' coping mechanisms of soil acidity problem

potatoes are more tolerant to soil acidity that of legumes; barley and wheat [17]. This could be important indicator for severity of soil acidity in the study area.

Farmers' Response to Soil Acidity Problems and Their Coping Mechanisms: Indigenous knowledge refers to the perception that farmers have about their natural and social environment, which they use to adopt, adapt and develop technologies to their local context [18]. The rationale for undertaking certain traditional practices among others is recognition of problems by the local people. Indigenous practices aimed at arresting the local priority problems.

Hence, the farmers' understanding and response to soil acidity problem was based on their observations of indicators mainly associated workability, yield decline and appearance of certain weed species such as Arebakash (*Spergula arvensis*) and Yeweftef (*Eragrostis cilianensis),* low and decline yield of barley, wheat, field pea and other crop species. Farmers' responses also focused on improving these problems. Nearly all the farmers who perceived soil acidity problem in their farm responded by applying either one or more of the soil management practices described on (Fig. 4).

More than 55% of the surveyed households at both kebeles employed good agronomic practices such as crop selection, adjusting sowing date and knowing critical weeding periods and use of farmyard manure on their farm to tackle soil acidity problems. However, lime application and use of acid tolerant species were not clearly innovated and understood (Fig. 4). Farmyard manure is perceived by farmers to improve organic matter content of soil, increase moisture retention and reduce soil acidity problems. However, the application is limited to backyard fields due to limited availability and high labor requirement for transportation. They also reported that it was not always possible to get sufficient material to make compost. Though the composition and amount of nutrients in manure are variable depending on the type of animal, ration fed, amount and type of bedding material, collection system and management between production and use; manure contains all the essential chemical elements needed by plants and its potential nutrient contribution is quite considerable [19].

Land is also left fallow as coping strategy when yields of most crops become very low in an attempt to improve soil fertility. Only about 10% of the surveyed households have experienced using fallow for nutrient recovery due to scarcity of land (Fig. 4). Farmers noted that early sowing after fallowing reduces severity of soil acidity.

Crop rotation is one of the agronomic practices used by the farmers to improve soil workability and soil nutrient recovery. In most cases, surveyed households use a crops rotation of teff-noug-teff on cultivated fields faraway from home whereas barley-potato-maize and then barley rotation is followed on the backyard fields. Some farmers employed intercropping. Potatoes are intercropped with maize mainly to improve 'exhausted' soils.

In addition to the stated management practices, quite a number of farmers shift their cropland to Eucalyptus plantation and grazing. About 42 and 36% of the respondents in Hateta and Denzuria peasant associations respectively change their cropland to grazing pasture (Fig. 5). However, the grass species grew on acidic soils are unpalatable and poor in performance to support the livestock. Most farmers expressed their aim to expand eucalyptus plantation prompted by its financial returns and suitability to their farmland.

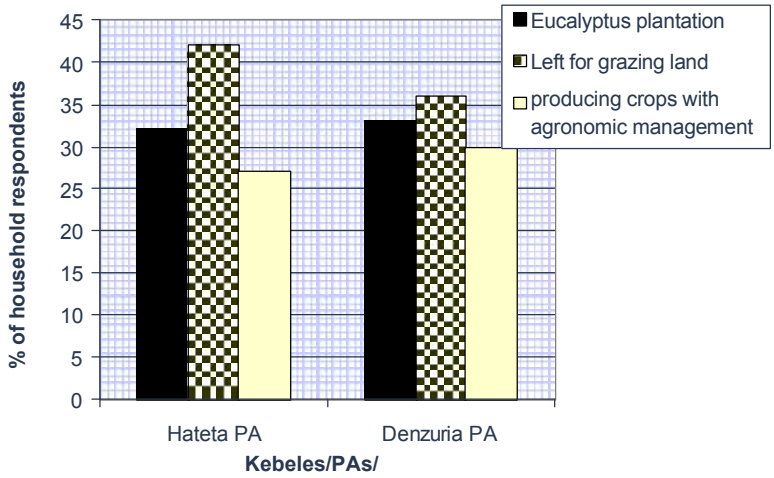

Fig. 5: Farmers' opinion for the purpose of acidic soil "*Gibiz Merate"*

Table 5: Farmers' preference of tree species under acidic soil condition

	Hateta Peasant Association			Denzuria Peasant Association		
Tree Species	Frequency	Percent	Cumulative Percent	Frequency	Percent	Cumulative Percent
Eucalyptus globulus	35.0	58.3	58.3	36.0	60.0	60.0
Acacia decurrens	12.0	20.0	78.3	12.0	20.0	80.0
Cupressus lusitanica	8.0	13.3	91.7	7.0	11.7	91.7
Indigenous trees	5.0	8.3	100.0	5.0	8.3	100.0
Total	60.0	100.0		60	100.0	

Source: Own survey (2008)

Farmers' Perception on Eucalyptus Plantation and Soil Acidity: Respondents claimed that forest cover used to be more than one third of the total area. However, due to population pressure and heavy utilization, the indigenous tree species are disappearing. Diminishing natural forest resources are being compensated by rapid expansion of exotic trees such as

Eucalyptus tree locally known as 'bahir zaf' (Table 5). On the average, a household owns 185 trees. The Eucalyptus species, in Awi area/Dega region/, *Eucalyptus globulus* ("*nech bahr Zaf*" in Amharic, "*fuchi bahr zaf*" in Awigni and Tasmanian blue gum in English) is the most dominant [20]. Bahr zaf/ Eucalyptus/ is preferred to other trees, because of its fast growth, do well on acidic soil, drought resistant, has a straight form for construction, split easily, easily propagated, its bark makes good rope. Furthermore, it leaves are used to source of energy for household use or sold to the local market.

Though Eucalyptus trees have proven themselves valuable to farmers, it is not without limitations. The farmers claimed Eucalyptus is not good for the soil. A comparative study on *Cupressus lusitanica* and *Eucalyptus globulus* (exotics) and natural forest effects on nutrient cycling in forested areas reported that the annual nutrient input by litter of the two exotics generally was much lower than that of the *Juniperus procera* and, in particular, that of the natural forest [21]. Besides, more than 61% of the surveyed households perceived Eucalyptus tree has a negative impact on stream flow and depletes underground water, furthermore the leaves are not decomposable nor it adds organic matter to the soil. It does have shading effect and harbor birds. Their claims agree with the observations of others researchers [20] in Banjashikudad and Fagta Lekoma Woreda of Awi zone. Nevertheless, despite the alleged drawbacks, farmers are expanding the plantation of Eucalyptus. This is mainly due to its economic feasibility for local and regional purposes as well as growing ability on acidic soil.

CONCLUSIONS AND RECOMMENDATION

Farmers in the study area have understood the problem of soil acidity, which is explained by irresponsiveness of the farmland to inorganic fertilizer

and poor performance of their crops. Such farmland is locally known as *'Gibiz Merate'*. Meaning, poorly responsive of farm inputs. Moreover, their understanding to soil acidity problem is based on their observations of indicators mainly associated with workability; yield decline, appreance of certain weeds species. Acidic parent material, high rainfall followed by erosion and intensively continuous cultivation are believed to be the probable causes for soil acidity. They have experiences on changing '*Gibiz*' to '*non-Gibiz'* by using *farmyard manure*, means of reclamation. Their action to cope up with the problem focused on use of farmyard manure around the homestead garden, shift the cropland to *Eucalyptus* plantation or for grazing.

Lime application as soil acidity reclamation is limited on farm demonstration trail and clear yield differences not yet evaluated. Most farmers engaged and intended to expand *Eucalyptus* plantation by realizing its economic importance and compatibility to their farmland. This acidification process leads to an increasing threat to agricultural and natural ecosystems in the study area. Thus, the study emphasize that soil acidity problem is critical in Ankesha district of Awi zone and calls the need for immediate intervention to amend the soil for crop production and sustainability of soil productivity.

Beyond taking measures to minimize the impact of human activities that cause soil acidification, the following recommendations are forwarded"

- It is advisable to add organic materials in the form of appropriately prepared and supplied compost on farmland.
- Participatory and a decision-making support system for farmers regarding the application of lime to acid soils should be adopted and implemented.
- Education and awareness raising program on management of acid soils should be established and encouraged in conjugation with agricultural extension service.
- Integration of government agencies, lime industry agencies and the agricultural community should involve seeking for soil acidity amendments and management options.
- Improvements on land management practices for sustainable productivity of soils and land use change has to be implemented as a long-term management strategy to improve soil acidity problems.
- Further work on soil analysis and detailed soil profile studies should be made to give a clear picture regarding the study area.

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