I. General introduction

The highlands of Ethiopia cover 45 % of the country's landmass and comprise 95 % of the cropland and 70 % of the livestock population (MOHAMED and ABATE 1995; CSO 1988). It is also estimated that 88 % of the human population settle in the highlands at an average density of 64 person km^{-2}. Soil fertility depletion and shortages of animal feed are priority problems in the highlands (SEYOUM et al. 2001; ICRAF 1990; AREGAWI 1989).

Ethiopia is among the sub-Saharan Africa countries with the highest rates of soil nutrient depletion. Continuous cultivation, soil erosion, leaching and continued removal of nutrients in crop harvests are the main causes of the depletion of soil fertility in the highlands (KINDU and TAYE 1997; HAILESLASSIE et al. 2006). FAO (1986) has estimated that 50% of the arable lands in the Ethiopian highlands are moderately to severely eroded. HAILESLASSIE et al. (2006, 2005), reported depletion rates of 122 kg N ha^{-1} yr^{-1}, 13 kg P ha^{-1} $yr^{-1}$and 82 kg K ha^{-1} yr^{-1} at a national level and 142 kg N ha^{-1} yr^{-1}, 19 kg P ha^{-1} yr^{-1}, 87 kg K ha^{-1} for the west Shewa zone in the Oromia region.

The shortage of animal feed occurs mainly during the dry season and the crop-fallow periods (when the fallow land is cultivated and the farmland is still under the crop cover) in the western Shewa highlands (KINDU et al. 2006). Natural pasture and crop residues are major sources of animal feed in the highlands. These feed resources in general are characterized by low digestibility, low protein content and poor mineral composition (SEYOUM and ZINASH 1989). According to JAYASURIYA (2002), the protein content of a natural pasture decreases from 12-14% to about 6-8% during the dry season. The decrease in crude protein content is also accompanied by an increase in fibre content. Therefore, the animal is faced with a low quality and relatively indigestible feed.

As a result of feed shortages, animals die at an early age, have a low milk yield, are marketed at a low price and provide weak draft power (KINDU 2001). Similarly, the harvest of crops gets lower over time because of soil fertility depletion. It is not uncommon for farmers in the high altitude areas of western Shewa to obtain a barley grain yield of < 1 t ha^{-1} on depleted soils. Therefore, the two key problems are contributing to low agricultural productivity, poverty and food insecurity and malnutrition in the highlands.

Substantial amounts of inorganic fertilizers are imported every year to ameliorate soil fertility problems. For instance, in the 2004/05 cropping season, the total fertilizer availability amounted to 482,000 metric tons (FAO/WFP 2006). However, smallholder farmers lack financial resources to purchase sufficient fertilizer to replace soil nutrients exported due to different nutrient outflow mechanisms. In addition to the inorganic fertilizers, organic fertilizer resources such as crop residues and animal manure are advertised for improving soil fertility.

This approach is significantly challenged by competing uses of crop residues and animal manure for feed and fuel sources, respectively. The foregone annual grain production as a result of using dung and crop residue for fuel in the Ethiopian highlands was estimated at 700,000 tons (MOHAMED 2000).

The introduction of suitable exotic tree and shrub species and the promotion of indigenous ones in the highlands with the participation of different partners is one of the options to increase biomass for soil improvement, supplemental animal feed, and other products and services. Fodder trees and shrubs serve as standing feed reserves so that herds are able to survive during critical feed shortage periods. High feeding quality in terms of protein and contents of some minerals, tolerance of a wide range of management practices, longevity, and the capacity to produce fodder when other species have become dormant in order to avoid harsh climatic conditions are some of the advantages of fodder trees and shrubs (PATERSON et al. 1998).

The utilization of tree and shrub species for soil fertility improvement is a viable and sustainable land-use alternative to enhance agricultural productivity. Trees can potentially improve soils through numerous processes including maintenance or increase of soil organic matter, uptake of nutrients from below the reach of crop roots, biological N-fixation, reduced loss of nutrients by erosion and leaching, increased water infiltration and storage, improved soil physical properties, reduced soil acidity and improved soil biological activity (YOUNG 1997).

Indigenous tree and shrub species that are used for soil fertility improvement and as sources of fodder in the high altitude areas of western Shewa have not been given much research attention. Similarly, there have been limited research attempts to screen exotic tree and shrub species on various soil types for fodder production, soil fertility improvement and other uses. Hence, different tree and shrub species evaluation studies have been carried out in the highlands of western Shewa with the following objectives:

II. Objectives of the study

The general objective of the study is to generate social and biophysical information for selected tree species that grow in different soil types and thereby develop recommendations, which can lead to species expansion and utilization. The specific objectives were to:

a) Quantify the contents of major nutrients, lignin and soluble phenolics in foliages, stems and flower buds from different tree and shrub species.
b) Assess soil macro- and micronutrients under some indigenous tree and shrub species on Haplic Luvisols.

c) Evaluate the performance of different exotic and indigenous tree and shrub species on Pellic Vertisols.
d) Evaluate the performance of different exotic and indigenous tree and shrub species on Nitisols.
e) Assess the chemical composition and anti-nutritional components in foliages and flower buds of some fodder tree and shrub species.