Evaluation of common indigenous tree and shrub species for soil fertility improvement and fodder production in the highland areas of Western Hewa, Ethiopia (KEF Projekt 145)

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Project partners:

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The major expected outputs from the project include the identification of socially acceptable and biologically superior indigenous fodder and soil improving tree species, the creation of capacity building forums for farmers and development agents, and the production of publications for the project partners and other scientific communities at all levels. Farmers, development agents, the Ethiopian Institute of Agricultural Research (EIAR), and the Institute of Forest Ecology at the BOKU University are project partners. So far, all the partners have played key roles in implementing the project activities.

Since fodder and soil fertility are priority research areas of the EIAR, the results from the current project will be scaled up to similar agro-ecologies of Ethiopian highlands. Research findings from the first component of the project are presented as a case study below. This case study focuses on farmers' preferences of indigenous tree and shrub species for fodder production and soil fertility improvement in the highlands of central Ethiopia.

Introduction

Soil fertility depletion and shortages of animal feed are priority problems in the highlands (ICRAF, 1990; Aregawi, 1989). As a result of feed shortages, animals die at an early age, offer low milk yield, make poor draft animals, and are marketed at a low price (Kindu, 2001). Similarly, crop production is affected by declining soil fertility. Huge amounts of inorganic fertilizers are imported annually to ameliorate soil fertility in the highlands. However, smallholder farmers lack

Foto 39: Children in the project area (© Kindu Mekonnen).

Foto 40: Flowers from D. torrida *(© Kindu Mekonnen).*

the financial resources to purchase sufficient inorganic fertilizer and replace soil nutrients which are exported due to different nutrient outflow mechanisms.

Exotic trees and shrubs have been introduced and promoted in the highlands to increase biomass for soil improvement and to provide supplemental animal feed. In some cases the genetic base and adaptation of the introduced species was found to be poor. In other cases pests and diseases have threatened some of the introduced species. Indigenous fodder and soil improving trees and shrubs can have advantages over the exotic species in terms of adaptability to the local environment, resistance to pests and diseases, availability of local planting material and familiarity to the farmers. So far, very little work has been dedicated to the identification of indigenous tree and shrub species that farmers use and prefer for fodder and soil fertility improvement.

Objectives

a. Identify tree and shrub species that are useful for fodder production and soil fertility improvement.

b. Identify the criteria that farmers use for assessing indigenous fodder and soil improving tree and shrub species.

c. Prioritize indigenous fodder and soil improving tree and shrub species using farmers' criteria.

d. Forward recommendations for further research on indigenous tree and shrub species.

Methodologies

Description of the study area

The study area is situated in the upper plateaus of the Dendi and the Jeldu Weredas (districts) in the western Shewa zone, central Ethiopia (9o 02′ 47′′ to 9o 15′ 00′′ N and 38o 05′ 00′′ to 38o 12′ 16′′ E, and 2900 to 3200 m.a.s.l). The Chilmo state forest borders the study area in the south. The soil is characterized as Haplic Luvisol. The rainfall pattern is bimodal. The main rainy season is from July to September with annual rainfall of 1399 mm. Barley is the most dominant crop, followed by potato and enset *(Ensete ventricosum).* Cattle, sheep and horses are dominant in the study sites. Farmers mainly meet their demand for cash by selling live animals and their products.

Survey

Two weredas (districts) and four kebeles (lower administrative units in the government structure) in the highlands of central Ethiopia were considered for the study. Accessibility and diversity of soil improving and fodder producing species were given much attention for the selection of the study area. Growing location and composition of tree and shrub species were investigated through direct observation, as well as through group and individual discussion approaches (Foto 41 and 42). A total of 150 farmers (respondents) participated in a questionnaire survey (Roothaert and Franzel, 2001; Thapa et al., 1997; Morrison et al., 1996; Mayr, 1996). The farmers' criteria for the selection and prioritization of fodder and soil improving species were identified through group discussion and quantified at the time of the questionnaire survey.

Foto 41 and 42: Interviews with farmers during field work (© Kindu Mekonnen).

Results and discussions

Household and farm characteristics

Out of 150 farmers, 85.3 percent were male and 14.7 percent female. Very low, low, intermediate and high-income farmers constituted 8.7 percent, 28 percent, 36.7 percent and 26.7 percent, respectively, of the total respondents. The household sizes of the respondents ranged from 2 to 14 persons. The mean household size was 7.53 persons. Fifteen percent of the respondents had a household size of 7 persons. There were more literate respondents than illiterate ones. 43 percent of the respondents had received formal education and 18.7 percent could write their names. On the other hand, the respondents who could not read and write at all made up 38 percent. The cultivable land holding of farmers ranged in size from 0 to 6 ha. The range for the number of cattle (oxen and cow) was between 0 and 5, for sheep between 0 and 30, and for horses between 0 and 5.

Composition of fodder and soil improving species

Farmers identified more than 37 tree and shrub species around homesteads, farmlands and other niches (Table 3). Out of a total of 37 species, 22 species increased fodder value, 7 improved soil fertility, and 8 both increased fodder value and improved soil fertility. Fodder and soil improving tree species were mainly concentrated around homesteads (Foto 43) and in forests. Very few indigenous tree and shrub species had spread to farmlands. More than 86 percent of the farmers need to plant trees around homesteads for better management and protection purposes. The percentage of farmers who mentioned a lack of seedlings, a free grazing livestock system and a lack of awareness as major problems for the planting of indigenous species was 60 percent, 40 percent and 25 percent, respectively.

Table 3: Fodder and soil improving tree and shrub species identified in the highlands of central Ethiopia.

Species	Local names	Family names	Major uses
Dombeya torrida (J.F. Gmel.) P. Bamps	Danisa	Sterculiaceae	OD[1], SFIM[2]
Hagenia abyssinica (Bruce) J.F. Gmel.	Heto	Rosaceae	SFIM, FOD
Buddleja polystachya Fres.	Anfari	Loganiaceae	FOD, SFIM
Maytenus senegalensis (Lam.) Exell.	Kombolcha	Celastraceae	FOD
Enset ventrcosum (Welw.) Sheeseman	Workie	Musaceae	FOD
Maesa lanceolata Forsk.	Abeyi	Myrsinaceae	FOD
Olea africana Mill.	Ejersa	Oleaceae	FOD
Rhamnus prinoides L' Her.	Gesho	Rhamnaceae	FOD
Rubus apetalus Poir.	Gora/Yedega Injore	Rosaceae	FOD, SFIM
Rubus pinnatus Willd.	Gura/Yedega Injore	Rosaceae	FOD, SFIM
Salix subserrata Willd.	Barodo	Salicaceae	FOD
Vernonia amygdalina Del.	Ibicha	Asteraceae	FOD
Vernonia auriculifera Hiern.	Chochinga	Asteraceae	SFIM, FOD
Myrica salicifolia Hochst. ex A. Rich.	Reji	Myricaceae	SFIM, FOD
Pittosporum viridiflorum Sims.	Sole	Pittosporaceae	FOD
Myrsine africana L.	Kechemo	Myrsinaceae	FOD
Arundinaria alpina K. Schum.	Kerkeha	Bambusaceae	FOD
Podocarpus gracilior Pilg.	Birbirsa	Podocarpaceae	FOD
Juniperus procera Hochst. ex Endl.	Gatira	Cupressaceae	SFIM
Lantana trifolia L.	Kusaye (kese)	Verbenaceae	FOD
Phytolacca dodecandra L' Her	Indode	Phytolaccaceae	SFIM
Hypericum revolutum Vahl	Hini (Ini)	Hypericaceae	FOD
Urtica simensis Hochst. ex steud.	Dobi (sama)	Urticaceae	SFIM
Achyranthes aspera L.	Dergu	Amaranthaceae	FOD
Calpurnia subdecandra L' Her. Schweikerdt.	Cheka (digita)	Papilionaceae	FOD
Schefflera abyssinica (Hochst. ex A. Rich.) Harms	Luke	Araliaceae	SFIM
Senecio gigas Vatke	Osolie	Asteraceae	SFIM
Kalanchoe deficiens (Forsk) Asch. & Schweinf.	Bosokie	Crassulaceae	SFIM
Pterolobium stellatum (Forsk.) Chiov.	Arangama/qontir	Caesalpiniaceae	FOD
Apodytes dimidiata E. Mey. ex Benth.	Odabeda	Icacinaceae	FOD
Dracaena steudneri Schweinf. ex.	Lankuso/Hareg	Agavaceae	FOD, SFIM
Trichilia roka (Forsk.) Chiov.	Anona	Meliaceae	SFIM
Stephania abyssinica (Qu. – Dill & A. Rich.) Walp.	Ido-Antuta/Yeayiti Areg	Menispermaceae	FOD
Clematis hirsuta Perr. & Guill.	Hida, Idefeti/Azo hareg	Ranunculaceae	FOD
Acacia abyssinica Hochst. ex Benth	Lafto/Bazra Girar	Mimosaceae	FOD
Nuxia congesta R. Br. ex Fres.	Qawisa/Chechiho	Loganiaceae	FOD
Maytenus ovatus (Wall. ex Wight & Arn.) Loes.	Anjito/Atati	Celastraceae	FOD

[1] *Fodder;* [2] *Soil fertility improvement.*

Farmers' selection criteria for fodder and soil improving species

Foto 43: Senecio gigas in the homestead (© Kindu Mekonnen).

Farmers ranked availability during the dry season and palatability for animals as top criteria for selecting indigenous tree and shrub species for fodder production (Table 4). Tree leaves and straw fill the gap of feed shortage in the dry season (April and May). Most farmers cut branches of trees and feed them to their animals (Foto 45). Some farmers allow their animals to feed on fallen leaves under fodder trees. There are also some farmers who feed leaves of *Dombeya torrida* with salt. The mixture of leaves and salt promotes the fattening of oxen and sheep. The utilization of industrial by-products (oil seed cake) is minimal. Only some rich farmers buy oil seed cake and feed it to their animals.

Table 4: Criteria used by farmers to evaluate indigenous fodder and soil improving tree and shrub species in the highlands of central Ethiopia.

Criteria	Number of respondents[a]	Score	Rank
1. Fodder production			
1.1. Tree related criteria[b]			
1.1.1. Coppicing ability	143	368	3
1.1.2. Availability during the dry season	150	555	1
1.1.3. High biomass	149	399	2
1.1.4. Fast growth	122	138	4
1.2. Animal related criteria[c]			
1.2.1. Palatable by animals	150	444	1
1.2.2. Harmless to animals	138	270	2
1.2.3. Improve weight of animals	53	64	3
2. Soil fertility improvement[d]			
2.1. Fertility related criteria			
2.2.1. Leaf shedding is so quick	148	649	1
2.2.2. Decomposition of leaves is fast	139	514	2
2.2.3. Fast growth	120	228	4
2.2.4. Easy propagation	118	204	5
2.2.5. Production of high biomass	138	469	3

Foto 44: Leaf shedding from H. abyssinica *(© Kindu Mekonnen).*

[a] *Number of respondents who identified the criteria. Sample size was 150 households.*

[b] *If a farmer selected the criteria first, it received a value of 4; if second, a value of 3; if third, a value of 2 and if fourth, a value of 1.*

[c] *If a farmer selected the criteria first, it received a value of 3; if second, a value of 2; if third, a value of 1.*

[d] *If a farmer selected the criteria first, it received a value of 5; if second, a value of 4; if third, a value of 3; if fourth, a value of 2 and if fifth, a value of 1. Score is sums of individual farmer value given to the respective criteria.*

Leaf shedding followed by decomposition received high rankings as an evaluation criterion for selecting soil improving tree and shrub species (Table 5 and Foto 44). Farmers also consider the change of the soil colour to black (96 percent of farmers), crop growth (88.7 percent of farmers) and crop yield close to trees (92 percent of farmers) as indicators for soil fertility improvement. In order to increase the productivity of their farmlands, farmers are in the habit of practicing different soil fertility amelioration methods separately or simultaneously. Fallowing, and the application of inorganic fertilizer (DAP and urea), animal manure or foliage from tree species are some of the methods currently used by farmers. The practice and utilization of the methods vary according to the capacity of the farmers. Those farmers who have enough livestock apply much of the animal manure on their farms.

Table 5: Indigenous fodder and soil improving tree and shrub species ranked based on farmers' criteria in the highlands of central Ethiopia.

Fodder species	No. of respondants[a]	Score
Hagenia abyssinica	148	790
Dombeya torrida	140	658
Buddleja polystachya	136	534
Maytenus senegalensis	128	417
Dracaena steudneri	92	227
Arundinaria alpina	68	131
Hypericum revolutum	59	110
Myrica salicifolia	55	107
Maytenus ovatus	15	28
Myrsine africana	7	27
Olea africana	10	27
Soil improving species	**No. of respondants[a]**	**Score**
Senecio gigas	142	743
Hagenia abyssinica	147	734
Dombeya torrida	133	512
Vernonia auriculifera	122	357
Buddleja polystachya	99	272
Myrica salicifolia	100	205
Leonotis africana	60	106
Kalanchoe deficiens	9	39
Dracaena steudneri	5	16
Juniperus procera	3	10
Maytenus senegalensis	3	8

Sample size was 150 households. Each household scored six preferred fodder tree species.

[a] *Number of respondants who selected the species in the top 6. If a farmer selected a species first, it received a value of 6; if second, a value of 5; if third, a value of 4; if fourth, a value of 3; if fifth, a value of 2 and if sixth, a value of 1. Score is sums of individual farmer value given to the respective species.*

Preferred species for fodder production and soil improvement

Farmers highly prefer *Hagenia abyssinica*, followed by *D. torrida* and *Buddleja polystachya* as fodder tree species, based on the animal and plant-related criteria (Table 5). On the other hand, farmers select *Senecio gigas*, *H. abyssinica*, *D. torrida* and *Vernonia auriculifera* as the most useful tree and shrub species for soil fertility improvement. In addition to the fodder and soil fertility improving value, some species provide marketable products. For instance, there is a higher need for *D. torrida* as a source of bee fodder than as fodder for other species. Farmers believe that the honey from *D. torrida* flowers (Foto 40) is of high quality in terms of taste and colour. Similarly, some farmers are in the habit of producing ropes from the bark of *D. torrida* which sell at good prices (Foto 46). Most of the top ranked fodder and soil improving species have been propagated from seed. Farmers find the propagation of *S. gigas* very easy in comparison to that of other species. They easily produce seedlings from cuttings taken from the stem and root parts of the shrub.

Foto 45: Farmers are feeding H. abyssinica *and* D. torrida *to their animals (© Kindu Mekonnen).*

Recommendations

a. Farmers have identified and ranked indigenous tree and shrub species for fodder production and soil fertility improvement based on physical features. It is therefore necessary to back up the farmers' indigenous knowledge with scientific investigations.

b. The market value of some products that are made from indigenous species needs more in-depth studies so as to enable poor farmers to generate additional cash income.

c. The possibility of propagating *S. gigas* from seed and *B. polystachya* from cuttings under the existing agro-ecological condition of the study area requires research.

Foto 46: Barks of D. torrida *rope making (© Kindu Mekonnen).*

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