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Farmers' perceptions about exotic multipurpose fodder trees and constraints to their adoption

Abebe Mekoya · Simon J. Oosting · Salvador Fernandez-Rivera · Akke J. Van der Zijpp

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Abstract Many organizations in Ethiopia have for many years promoted exotic multipurpose fodder trees (EMPFT) for livestock feed and soil improvement. Despite the apparent benefits, the number of farmers planting these trees was low. The objectives were to elucidate farmers' perceptions about their use value, management practices and constraints to adoption in three districts representing annual (one wheat-based and one teff-based) and perennial (coffee-based) crop-livestock systems in the Ethiopian highlands. Data were collected from 235 farm households. Most farmers (95.3%) had awareness of EMPFTs and the principal information sources were development agents (75.3%). Over half of the farmers were motivated to plant EMPFTs for feed value. Motivation for other purposes depended on cropping system, vegetation cover and availability of alternative local fodder trees in the area. Farmers had positive perceptions about EMPFTs for their feed value and contribution to soil conservation. Current adopters had a mean number of 587 (SE ± 84) EMPFTs per farm. Major constraints to adoption of EMPFTs were agronomic problems, low multipurpose value, and land shortage. Majority of farmers (89.8%) were interested to either continue or begin fodder tree development. Of the interested respondents, 44.5% preferred local fodder trees whereas 55.5% preferred EMPFTs. We conclude that farmers are aware of use values of EMPFTs while perceived constraints suggest that introduction of EMPFTs need consideration of farmers multiple criteria, but also awareness of feeding fodder trees and resource availability. Moreover, current development approaches have to recognize the importance of involving the end-users at all stages through participatory approaches to enhance adoption.

Keywords Adoption · Awareness · Development constraints · Ethiopian highlands · Farm households · Values

A. Mekoya · S. J. Oosting (✉) · A. J. Van der Zijpp
Animal Production Systems Group, Wageningen University, P.O. Box 338, 6700 AH Wageningen, The Netherlands
e-mail: Simon.Oosting@wur.nl

A. Mekoya
Amhara Region Agricultural Research Institute, P.O. Box 527, Bahir Dar, Ethiopia

S. Fernandez-Rivera
International Livestock Research Institute, P.O. Box 5689, Addis Ababa, Ethiopia

Introduction

Agriculture in the Ethiopian highlands (areas above 1,500 m a.s.l, receiving >700 mm annual rain fall and having a mean daily temperature of <20°C) is largely based on intensive cultivation of annual and perennial crops in mixed crop-livestock farming systems. The favourable climate and soil fertility allowed for high human and livestock population pressure on available land (Jahnke and Asamenew 1983). The crop and livestock sub-sectors compete for scarce farm resources. As a result, the livestock productivity is generally low if compared to the apparent potential (EARO 1998). Among contributing factors to low livestock productivity, the overriding constraint is inadequate feed supply, which comes mainly from marginal natural pastures and crop residues (Tsige Yohannes 2000; Assefa 2005). Two factors limit performance of animals fed on poor pastures and cereal straws: the amount consumed is restricted and the nutritive value per unit ingested feed is relatively low (Reed et al. 1990; Tsige Yohannes 2000). However, crop residues and natural pasture are still the principal feed sources and could provide a valuable source of energy if supplemented with protein rich feeds (Oosting 1993). Several studies recommend supplementation with multipurpose fodder trees as perhaps the best-suited method for small-scale farmers (Smith 1992; Kaitho 1997; Solomon 2002).

Since the 1970s many organizations in Ethiopia promoted exotic multipurpose fodder tree (EMPFT) species such as *Sesbania sesban*, *Leucaena leucocephala*, *Calliandra calothyrsus* (here after referred to as Sesbania, Leucaena, and Calliandra) and Tree Lucerne, for supplementary feeding of livestock and soil improvement. Despite the significant development efforts and the apparent benefits, the number of farmers planting these trees was low. We hypothesized that understanding farmers' perception about values of fodder trees at the farm and constraints to introduction and growing of exotic multipurpose fodder trees will contribute to better understanding of how and which innovations should be introduced. The present research was conducted to assess the values of multipurpose fodder trees and to study farmers' practices of growing fodder trees and the constraints they perceive for introducing and growing exotic multipurpose fodder trees in the crop-livestock mixed farming system of the Ethiopian highlands.

Materials and methods

Conceptual framework

One's perception depends on ones frame of reference. According to Boogaard et al. (2006) four factors contribute to a frame of reference: knowledge, experience, values and interests.

Knowledge and experience: perception of an innovation is influenced by the household's knowledge, knowledge source, and how this knowledge is transferred into the community (Andrew and Rikoon 1997). In the present study we assessed knowledge as awareness. Experience serves as a yardstick from which new practices are evaluated (Biggelaar and Gold 1995; Andrew and Rikoon 1997). The extent of constraints prevailing in the locality and the significant contribution of the innovation (values) to alleviate constraints may change farmers' perception (Napier et al. 1986; Napier and Napier 1991).

Values and interests: values can be defined as matter important to people in a collective or individual setting. Farmers' interests have a more individual nature and are related to family subsistence, farm economics but also to social-cultural issues. Values and interests are therefore partly overlapping. With regard to fodder trees, values and interests become explicit in the role and function of fodder trees in the farming system.

Since farming systems differ between agro-climatic zones, and resource availability at the farm also determines the farming system, the present study compares different districts (which represent different farming systems) and wealth groups within districts.

Regions and farming systems

This study was conducted from August to December 2004, in Lay-Armachuho and Debay-Tilatgen districts of Amhara region, in the north-western highlands, and in Dale, Shebedino and Wondo districts (here after called Sidama district) of Southern region, in the southern highlands of Ethiopia. The altitudes range from 2,200 to 2,400 m, 2,300 to 2,600 and 1,800 to 2,000 m a.s.l. for Lay-Armachuho, Debay-Tilatgen and Sidama districts respectively. Average annual rainfall for Lay-Armachuho and Debay-Tilatgen districts was 1,100 and 1,200 mm with a mono-modal pattern from July to September. The average annual rainfall for Sidama district was 1,320 mm with a bi-modal distribution from March to April and June to September.

The agricultural production systems in Lay-Armachuho and Debay-Tilatgen district are annual crop-based livestock system respectively wheat-based and teff (*Eragrostis tef*)-based whereas a perennial (coffee) crop-based livestock system characterizes Sidama district (Jahnke and Asamenew 1983). Average land holding was 1.64, 1.38 and 1.06 ha for Lay-Armachuho, Debay-Tilatgen and Sidama districts, respectively. In Lay-Armachuho and Debay-Tilatgen districts about 98% of crop land was allocated for annual crops. While in Sidama district 75% of crop land was used to grow perennial crops. An extensive livestock production system (free grazing) dominates Lay-Armachuho and Debay-Tilatgen districts whereas in Sidama district tethering is the common practice. The average livestock number per farm was 4.1, 3.4 and 2.7 tropical livestock unit (TLU) for Lay-Armachuho, Debay-Tilatgen and Sidama districts, respectively. The livestock species contributing most to farm income was cattle in Lay-Armachuho and Sidama and sheep in Debay-Tilatgen. A detailed description of the agro-ecology, farm and household characteristics of the study districts is presented in Table 1.

Survey methodology

Regions, districts and Peasant Associations (PAs) (the smallest administrative unit within a district) for this study were selected by employing multi-stage purposive sampling (beginning from regions to districts and PAs). Data from development organizations were used to select farms based on criteria: agro-ecology for region, more than five years of introduction of fodder trees and the type of crop-livestock system for districts, sufficient number of adopters (those who planted and utilized EMPFT) and non-adopter households (those who did not adopt EMPFT but use local fodder trees for feeding and other purposes) for PAs and presence of livestock for individual farms. Within each of the three study districts twelve PAs were selected and from the list of candidate farmers within each PA 7 or 8 non-adopting and 8 or 9 currently adopting farm households were randomly selected. However, for the group of discontinued adopters (those who abandoned using EMPFT) all available farmers were selected within the PAs included in the study due to the limited number of discontinued adopters. Two hundred thirty five farm households (98 adopters, 93 non-adopters and 44 discontinued adopters) from Lay-Armachuho, Debay-Tilatgen and Sidama districts were included in the present study. The distribution was 31, 34 and 33 for adopters, 30, 30 and 33 for non-adopters and 27, 5 and 12 for discontinued adopters in Lay-Armachuho, Debay-Tilatgen and Sidama districts, respectively. After selection, farmers were further classified into three wealth categories based on land size and livestock converted to tropical livestock unit (TLU) into poor (those who possess ≤1 ha land and ≤1.6 TLU), medium (those with 1–2 ha land and 1.7–4.0 TLU) and rich (those with ≥2 ha land and ≥4.0 TLU). The distribution of wealth groups was 23, 22 and 39 for poor farmers, 23, 28 and 27 for medium farmers, and 42, 19 and 12 for rich farmers in Lay-Armachuho, Debay-Tilatgen and Sidama districts, respectively.

Data collection and analysis

Data collection was by household interviews in local language by trained enumerators using a pre-tested, structured questionnaire. From each household farm land characteristics (farm size, allocation, ownership type), socio-economic characteristics (age, sex, education, economic activities engaged in), livestock characteristics (number, herd composition, purposes of keeping livestock, feed resources and feeding practices) and detailed information about fodder trees (farmers' awareness of, perception about and motives to plant EMPFT, tree number and EMPFT species available on-farm, use values, management practices, and constraints to adoption) were assessed.

Depending on the nature of data, chi-square tests, analysis of variance and regression analyses were employed to compare districts, wealth and adoption groups. The data on number of EMPFT owned was not normally distributed and mean comparisons were done on the log-transformed data. Data were analyzed using SPSS (2002) and SAS (2000) statistical packages.

Results

Awareness and experience

Most farmers (95.3%) had awareness about planting EMPFT. The sources for information about introduction and use of EMPFT were development agents

Table 1 Agro-ecological and farm household characteristics of the study districts in the Ethiopian highlands

Descriptions	Districts		
	Lay-Armachuho	Debay-Tilatgen	Sidama
Geographical coordinates	12°39′66″ and 12°42′45″ N 37°26′99″ and 37°28′42″ E	10°31′87″ and 10°33′20″ N 37°57′89″ and 37°59′04″ E	6°27′46″ and 6°46′20″ N 34°4′36.6″ and 38°12′54″ E
Altitude (m.a.s.l.)	2,200–2,400	2,300–2,600	1,800–2,000
Rainfall (mm)	1,100	1,200	1,320
Rainfall pattern	Mono-modal	Mono-modal	Bi-modal
Rainy seasons	June–September	June–September	March–April, June–September
Soils	Leptosols	Pellic vertisols	Nitosols
Vegetation cover	Poor	Medium	Good
Agricultural production system	Wheat-based crop-livestock	Teff-based crop-livestock	Coffee-based crop-livestock
Land use			
Average land holding (ha)	1.64	1.38	1.06
Average crop land (ha)	1.36	1.31	0.94
Average grazing land (ha)	0.27	0.06	0.12
Area covered by annual crops (%)	97.8	99.4	25.5
Major crops	Duragn[b], faba-bean, wheat, barley	Teff, wheat, faba-bean, rough pea	Coffee, enset (*Enset entricosum*), maize, sugar cane
Herd size (TLU[a])	4.1	3.4	2.7
Predominant livestock	Dairy (crossbreds), draught (local cattle), sheep, goats	Draught (local cattle), sheep	Dairy (crossbreds + local), sheep, goats
Major feed resources	Communal and private grazing, crop residues	Communal and private grazing, crop residues	Perennial crop leaves, local fodder trees
Feed shortage seasons	February–June	December–August	February–June
HH characteristics			
Mean age of household head (years)	41.8	37.5	42.1
Mean family size	7.1	5.7	7.9
Education status (%)			
Illiteracy	31.8	30.4	14.1
Read and write	56.8	50.7	28.2
Elementary education and above	11.4	18.8	57.7

[a] To convert in to one TLU (250 kg live weight) a mean weight in kg were used; 275 for oxen, 200 for cows, 150 for bulls, 125 for heifers, 50 for calves, 22 for sheep and goats, 100 for donkeys and 200 for horses as applied by Gryseels (1988)

[b] Duragn is a crop type where barley and wheat are grown mixed on the same land

(75.3%) and neighbouring farmers (17.4%) with a significant ($P < 0.05$) difference between districts, adoption groups and wealth groups (Table 2).

Neighbouring farmers were an important information source for non-adopters. For more than 94% of adopters and discontinued adopters, development agents were the principal information source. Farmer-to-farmer information exchange was relatively high in Debay-Tilatgen and Sidama districts and for poor farmers (Table 2).

Current and discontinued adopters of EMPFT had experience of growing EMPFT from three to fifteen years. There was a significant ($P < 0.05$) difference between districts. In Debay-Tilatgen district, a lower

Table 2 Awareness of adopters, non-adopters and discontinued (D-) adopters and major sources of information about EMPFTs in the Ethiopian highlands

Variables	Awareness of EMPFTs[b] (proportion responding "yes")	Major information source (% respondents)			
		Development agents	Neighbour farmers	Both	No source
Districts					
Lay-Armachuho	98.9	84.1	11.4	3.4	1.1
Debay-Tilatgen	98.6	75.4	21.7	1.4	1.4
Sidama	88.5	65.4	20.5	2.6	11.5
P	0.00	0.01			
Adoption groups					
Adopters	100	94.9	4.1	1.0	0.0
Non-adopters	88.2	45.2	37.6	5.4	11.8
D-adopters[a]	100	95.5	4.5	0.0	0.0
P	0.00	0.00			
Wealth groups					
Poor	96.4	61.9	31.0	3.6	3.6
Medium	96.2	84.6	9.0	2.6	3.8
Rich	93.2	80.8	11.0	1.4	6.8
P	0.57	0.01			
Overall ($n = 235$)	95.0	75.3	17.4	2.6	4.7

[a] D-adopters are farmers discontinued from EMPFT development

[b] EMPFTs = Exotic multipurpose fodder trees; *P*-values are chi-square probabilities

proportion of farmers had a long term experience, but a higher proportion had a medium term experience than in the other districts. There was no significant difference between wealth groups (Table 3).

Values and interests

Of the responses given by current and discontinued adopters (each respondent could choose more than

Table 3 Length of experience of growing EMPFTs and important functions of EMPFTs as perceived by current and discontinued adopters in the Ethiopian highlands

Variables	Length of experience of growing EMPFTs (% respondents)			Functions[b] (% responses)				
	Short ≤5 years	Medium 6–10 years	Long >10 years	Coffee shade	Feed	Fence	Fuel	SWC[a]
Districts								
Lay-Armachuho	20.7	36.2	43.1	0.0	71.3	16.3	6.3	6.3
Debay-Tilatgen	17.9	66.7	15.4	0.0	41.1	22.1	12.6	24.2
Sidama	15.6	40.0	44.4	30.9	47.9	4.3	5.3	11.7
P	0.02			0.00				
Wealth groups								
Poor	20.0	40.0	40.0	14.3	55.6	11.1	11.1	7.9
Medium	20.8	41.5	37.7	11.4	46.5	18.4	9.6	14.0
Rich	14.8	53.7	31.5	7.6	57.6	10.9	4.3	19.6
P	0.68			0.17				
Overall ($n = 142$; $n = 489$)	18.3	45.8	35.9	10.8	52.4	14.1	8.2	8.2

[a] SWC = Soil and water conservation

[b] Farmers could select more functions

P-values are chi-square probabilities

one important use value of EMPFT on his farm), feed value as motivator for introducing and/or growing EMPFT represented 52.4%. A significant ($P < 0.05$) difference was observed between districts: In Sidama, planting (fodder) trees for coffee shade was important, while in Debay-Tilatgen district soil fertility, live fence, and fuel-wood were relatively important motives. There was no significant association between wealth groups and EMPFT functions (Table 3).

Within the group of adopters 85.9% of respondents had positive response on the feed value of EMPFTs on animal productivity with a significantly ($P < 0.05$) lower proportion of positive respondents for Sidama than for the other districts. Among the important nutritional attributes of fodder trees "better body condition" got overall 47.4% of responses (farmers could select more than one attribute), followed by milk production (30.1% of responses) and improved straw intake (22.5% of responses). Ranking of attributes differed significantly ($P < 0.05$, chi-square) between districts. Body condition score was highly ranked in Sidama, milk production got relatively few responses in Debay-Tilatgen and improved straw intake was unimportant in Sidama (Table 4).

Of the adopters 39.8% of respondents perceived the contribution of EMPFT to soil and water conservation as important, 52.0% as medium and 8.2% as unimportant. Relatively more adopters in Debay-Tilatgen valued EMPFT as important for soil and water conservation than in the other districts (chi-square, $P < 0.05$). Perception of importance of EMPFTs for soil and water conservation was also significantly ($P < 0.05$) associated with wealth group (Table 4).

The majority (73.5%, not in table) of adopters perceived the importance of EMPFT for fuel wood as limited. The value of EMPFT to replace manure was relatively important in Lay-Armachuho (for 54.8% of adopters), less so in Debay-Tilatgen (26.5%) and very low in Sidama (9.1%) without significant ($P < 005$) differences between wealth groups. Adopters valued the contribution of EMPFTs to crop production as absent (24.5%) or limited (75.5%) (Table 4).

Fodder tree resources and management practices

Across districts 88.8% of adopters planted Sesbania, 8.8% Calliandra, and 2.5% Leucaena (not in table). In

Table 4 Current adopters' perception about values of exotic multipurpose fodder trees in the Ethiopian highlands

Variables	Feed value (proportion responding "yes")	Productivity improvement (% of responses)[a]			Extent of contribution to soil and water conservation (% of respondents)			Role to replace manure (proportion responding "yes")	Contribution to crop production (% of respondents)	
		Better body condition	Better milk production	Improved straw intake	None	Little	Much		None	Little
Districts										
Lay-Armachuho	87.9	40.5	33.9	25.6	3.2	74.2	22.6	54.8	22.6	77.4
Debay-Tilatgen	94.9	48.6	16.7	34.7	2.9	23.5	73.5	26.5	17.6	82.4
Sidama	75.6	60.7	39.3	0.0	18.2	60.6	21.2	9.1	33.3	66.7
P	0.03	0.00			0.00			0.00	0.31	
Wealth groups										
Poor	82.9	52.7	23.6	23.6	10.0	50.0	40.0	35.0	25.0	75.0
Medium	86.9	48.3	31.5	20.2	10.0	35.0	55.0	27.5	25.0	75.0
Rich	87.0	43.8	32.4	23.8	5.3	71.1	23.7	28.9	23.7	76.3
P	0.75	0.75			0.04			0.83	0.99	
Overall ($n = 98$)	85.9	47.4	30.1	22.5	8.2	52.0	39.8	29.6	24.5	75.5

[a] Farmers could select more than one perceived productivity improvement option

Lay-Armachuho and Debay-Tilatgen districts Sesbania, was the sole EMPFT species grown by farmers whereas in Sidama district the majority of farmers grew more EMPFT species. The mean number of EMPFTs available on-farm by a current adopter household was 587 trees. Current adopters in Sidama had significantly less trees than those in the other districts, while rich current adopters had more trees than adopters in the other wealth groups (Table 5).

The initial sources of seeds and seedlings were development organizations (95.4%) either directly or via contract farmers. Farmer-to-farmer exchange of seeds and seedlings was very low (4.6%), though higher in Sidama than in the other districts ($P < 0.05$) and higher for poor farmers than for the other wealth groups ($P < 0.05$). After establishment of the parent stock 71.4% of current adopters continued to acquire freely from development organizations and contract farmers for replacement and expansion. Backyard and farmland plantation were the two major development strategies exercised by 68.3% and 19.7% of the current adopters, respectively. Farmers in Sidama planted EMPFTs more often in farmland than farmers in the other districts ($P < 0.05$) (Table 5).

The number of EMPFT a household (current adopter) owned was positively ($P < 0.05$) correlated with livestock number (r = 0.35), number of crossbreds (r = 0.39) and land size (r = 0.24). Multiple regression analysis revealed land size and number of crossbreds as significant ($P < 0.05$) factors (Regression: Trees number = −38 (SE 84.1; ns) + 7 (SE 15.7; ns)* livestock number + 207.2 (SE 60, $P = 0.001$)* crossbred number + 273 (SE 112.2; $P = 0.017$)* land size (ha); $R^2 = 0.33$, $n = 98$, rsd = 478). Relationships within districts and wealth groups did not differ significantly from the overall regression.

Fodder trees can be used for feeding 6–8 months after plantation. Sesbania and Calliandra were fast in growth and could be cut for feed 12 months after planting. The average age of cutting for feed and fuel wood among current adopters was 10.4 and 49.8 months respectively without significant effects of district and wealth group except for the age of initial cutting, which was 9.6 (SE 0.38) months for rich farmers, significantly higher than for poor (11.1 (SE 0.48) months) and medium (10.9 (SE 0.42) months) farmers (Table 6).

The average annual frequency of cutting fodder trees was 2.6 times. There was significant difference ($P < 0.05$) between districts. Farmers in Sidama district cut more frequently than those in the other districts. Among respondents, 37% of farmers cut during December–May, 28.7% of farmers during

Table 5 Number of exotic multipurpose fodder trees available on current adopters' farms, seedling sources, plantation area in the Ethiopian highlands

Variables	Trees household^{-1}		Seedling source (% respondents)		Seedling raising (proportion responding "yes'')	Plantation area (% respondents)		
	Number ± (SE)	Natural log ± (SE)	Neighbour farmers	DOs[A]		Backyard	Farm land	Both
Districts								
Lay-Armachuho	1,014 ± 213	6.0 ± 0.23^{a}	1.5	98.5	29.0	94.8	1.7	3.4
Debay-Tilatgen	566 ± 102	6.0 ± 0.22^{a}	0.0	100.0	23.5	94.9	2.6	2.6
Sidama	207 ± 63	4.4 ± 0.23^{b}	15.2	84.8	33.3	11.1	57.8	31.1
P			0.00		0.67	0.00		
Wealth groups								
Poor	242 ± 176	4.9 ± 0.32^{b}	14.0	86.1	25.0	65.7	20.0	14.3
Medium	405 ± 124	5.3 ± 0.22^{b}	1.5	95.5	20.0	62.3	24.5	13.2
Rich	960 ± 128	6.0 ± 0.23^{a}	1.6	98.4	39.5	75.9	14.8	9.3
P			0.01		0.15	0.62		
Overall (*n* = 98)	587 ± 84	5.5 ± 0.15	4.6	95.4	28.6	68.3	19.7	12.0

Means in a column with different superscripts are significant at $P < 0.05$; *P*-values are chi-square probabilities

[A] DOs: development organizations

Table 6 Harvesting parameters for exotic multipurpose fodder trees at current adopters' farms in the Ethiopian highlands

Variables	Initial cutting age (mean ± SE) for		Cutting frequency year^{-1} (mean ± SE)	Cutting seasons (% respondents)			
	Feed	Fuel wood		Dec–May	Jun–Aug	Sep–Nov	Not specific
Districts							
Lay-Armachuho	10.4 ± 0.4	47.3 ± 2.3	2.6 ± 0.1^{b}	27.5	10.0	5.0	57.5
Debay-Tilatgen	10.2 ± 0.4	51.4 ± 2.7	2.5 ± 0.1^{b}	43.3	18.3	21.7	16.7
Sidama	10.6 ± 0.4	50.2 ± 2.1	3.0 ± 0.2^{a}	36.8	10.5	15.8	36.8
P				0.00			
Wealth groups							
Poor	11.1 ± 0.5^{b}	49.0 ± 3.5	2.8 ± 0.2	47.1	8.8	17.6	26.5
Medium	10.9 ± 0.4^{b}	51.0 ± 2.1	2.6 ± 0.1	34.8	21.7	15.9	27.5
Rich	9.6 ± 0.4^{a}	48.9 ± 2.1	2.8 ± 0.1	33.3	5.6	13	48.1
P				0.05			
Over all ($n = 98$)	10.4 ± 0.23	49.8 ± 1.4	2.6 ± 0.07	36.9	13.4	15.3	34.4

Means in a column with different superscripts are significant at $P < 0.05$; *P*-values are chi-square probabilities

September–November and June–August, and 34.4% of farmers did not follow specific seasons. Seasonality of cutting was associated with district and wealth groups (Table 6).

Constraints to adoption, future interest and preference of farmers

Non-adopters, current and discontinued adopters were asked to select maximally five constraints they envisage or experienced for establishing and growing EMPFT (Table 7). The major constraints were related to agronomic problems (31.8% of responses; low biomass, short life, incompatibility to the cropping system, adaptability), low multipurpose value (20.6% of responses), and land shortage (18.2% of responses). However, there was a significant ($P < 0.05$) association between constraints and districts, adoption groups and wealth groups. Agronomic problems and low multipurpose value were important constraints for Lay-Armachuho and Sidama districts, whereas, land shortage was the major impediment of adoption for Debay-Tilatgen district. Non-adopters mentioned low multipurpose value of EMPFTs and land shortage as important constraints while current and discontinued adopters mentioned agronomic problems as an important constraint (Table 7).

Non-adopters, current and discontinued adopters were asked whether they were interested to either continue or (re)start growing of multipurpose fodder trees. Interest to do so was expressed by 89.8% of farmers. Of those interested to begin or continue fodder tree growing, 44.5% preferred local multipurpose fodder tree species and 55.5% preferred EMPFTs. A majority of farmers in Lay-Armachuho and Sidama districts preferred local multipurpose fodder trees, while all farmers in Debay-Tilatgen district preferred EMPFTs. Current adopters preferred EMPFT whereas a majority of discontinued adopters (91.7%) and non-adopters preferred local multipurpose fodder trees (Table 8).

Discussion

Awareness and experience

The present study showed that most farmers were aware of the possibility of growing and utilizing EMPFTs and also of possible benefits. However, being aware about an innovation does not necessarily lead to adoption. As we observed in the present study, all discontinued adopters were well aware of and used EMPFTs for certain period whereas the majority of non-adopters (88.2%) had awareness of EMPFTs, but were reluctant to adopt. Decisions to adopt a given practice may require suitable bio-physical and socio-economic environments, in addition to adequate knowledge and favourable attitudes. When these factors are not in congruence, farmers' practices show divergence from their awareness and attitudes.

Table 7 Constraints perceived by current and discontinued (D-) adopters, non-adopters for adoption and growing of exotic multipurpose fodder trees in the Ethiopian highlands

Variables	Perceived constraints (% of total responses)							
	Agronomic problem	Low multipurpose value	Land shortage	Lack of utilization awareness	Labour shortage	Free grazing	Harbour pest	Others
Districts								
Lay-Armachuho	37.2	25.5	10.9	3.8	13.4	2.9	2.1	4.2
ebay-Tilatgen	6.5	2.9	39.9	18.8	8.0	16.7	1.4	5.7
Sidama	45.3	28.6	10.6	8.7	3.1	0.0	0.0	1.9
P	0.00							
Adoption groups								
Adopters	38.3	12.1	20.3	10.2	5.1	8.6	1.2	4.3
Non Adopters	0.0	32.3	30.1	16.5	11.3	2.3	0.0	7.5
D-adopters	49.0	24.8	4.0	0.7	13.4	3.4	2.7	2.0
P	0.00							
Wealth groups								
Poor	25.8	23.9	18.4	12.9	8.0	3.1	0.0	7.9
Medium	31.0	19.9	23.4	10.5	5.8	7.0	0.6	1.8
Rich	37.3	18.6	13.7	4.9	12.3	6.4	2.9	4.0
P	0.00							
Overall ($n = 538$)[a]	31.8	20.6	18.2	9.1	8.9	5.6	1.3	4.5

[a] Maximally five constraints per farmer; *P*-values are chi-square probabilities

Table 8 Future interest among current and discontinued adopters and non-adopters to continue or start growing fodder trees, and preference for local or exotic multipurpose fodder tree species in the Ethiopian highlands

Variables	Future interest (percentage of farmers responding "yes")	Preferred fodder tree species (% respondents)	
		Local	Exotic
Districts			
Lay-Armachuho	100.0	64.8	35.2
Debay-Tilatgen	84.1	0	100
Sidama	83.3	56.9	43.1
P	0.00	0.00	
Adoption groups			
Adopters	92.9	9.9	90.1
Non adopters	90.3	61.9	38.1
D-adopters	81.8	91.7	8.3
P	0.13	0.00	
Wealth groups			
Poor	86.9	54.8	45.2
Medium	85.9	35.8	64.2
Rich	97.3	42.3	57.7
P	0.04	0.07	
Overall ($n = 235$[a], 211[b])	89.8	44.5	55.5

[a] Future interest

[b] Preferred fodder tree type; *P*-values are chi-square probabilities

Semgalawe (1998) and Tesfaye (2003) who studied adoption of soil and water conservation practices in Tanzania and Ethiopian highlands also reported that farmers' knowledge on and attitudes to soil and water conservation have a basic, but limited role in determining their practices, which may demonstrate as well that fodder development practices are affected by factors other than awareness and perception of values.

It was observed in the present study that farmers feed less of the fodder tree biomass than recommended. This could be a lack of awareness among farmers of an optimal feeding strategy for animal production, but it could also be related to other constraints e.g. a different farming objective than livestock (coffee in Sidama), resource availability (limited land and labour) or agronomic problems. The latter, however, relates to in part to knowledge of tree management.

The channel of information source in the present study was unidirectional, top-down from development agents to farmers. Information exchange among farmers was generally low, which may affect the extent of adoption since farmers could learn needs and practices from other farmers. Hence, build up of a farmer-to-farmer information exchange system through participatory approaches will help develop trust of farmers to adopt an innovation. In an adoption study in the highlands of central Kenya, Sinja et al. (2004) and Wanyoike (2004) also reported that the spread of fodder legume technology was significantly enhanced by participatory, bottom-up methods especially farmer-to-farmer extension.

Values and interests

Values and interests with regard to EMPFTs are reflected in their functions at farms. The high importance given to the feed function of EMPFTs suggests prevalence of feed shortage with regard to quality and quantity in all districts and wealth groups. The importance of other functions depended on the farming system, and vegetation cover of the area. For instance, in Debay-Tilatgen district (due to intensive utilization of land for cropping) the vegetation cover was poor and availability of alternative local fodder trees on farmlands was scanty. Hence, important functions of EMPFTs here were soil and water conservation, live fence and fuel wood. On the other hand, coffee is the dominant perennial crop grown in Sidama district and growing EMPFTs for coffee shade was an important function. EMPFT-functions in the present study compare to those in reports of Franzel et al. (2003) and Poshiwa et al. (2006) in Kenya and Zimbabwe. The present study showed that farmers perceived EMPFTs positively for feeding value and contribution to soil and water conservation in line with results about utilization of multipurpose fodder trees in the Philippines where Calub (2003) concluded that farmers appreciated fodder trees and shrubs like Leucaena and *Glicirida sepium* for their role in bridging the gap in fodder supply during dry months and also to avoid soil degradation. The positive perception of farmers about feed value of EMPFTs in Lay-Armachuho was associated with a high fodder tree availability and importance of (crossbred) dairy cows in the farming system. While in Sidama, even though farmers had crossbred dairy cows, their perception about the feed value of EMPFTs was lower as compared to Lay-Armachuho district, which may be associated with the lower number of trees they had but also to the availability of local multipurpose fodder trees which they perceive better than or comparable to the exotics. Also Franzel et al. (2003) and Paterson et al. (1998) reported that farmers appreciated the feed value of fodder trees if they had sufficient fodder trees and experience of feeding dairy cows. Furthermore, the difference in the ranking of attributes for productivity improvement could be attributed to the difference in the production objectives of each farming system as well as the extent of utilization of crop residues. In Debay-Tilatgen district, cattle are reared mainly for draught purpose and sheep served as a main source of income. Here, the nutritional attribute of fodder trees was more for body condition improvement and increasing straw intake than milk production. Conversely, in Sidama the contribution of crop residues as a feed resource was lower compared to the other districts and consequently the attributes of fodder trees to increase straw intake were not recognized.

The difference in importance of the function of EMPFTs for soil and water conservation between districts could be explained by differences in vegetation cover and availability of alternative trees. Compared to other districts, Debay-Tilatgen district had poor vegetation cover and a low availability of local fodder trees, and farmers gave more importance to the function of soil and water conservation of EMPFTs. Our results agree with the reports of Roose and Ndayizigiye (1997) in Rwanda and McDonald et al. (1997) in Jamaica. Both studies described that in the mountains of Jamaica and Rwanda hedge rows of Calliandra and Leucaena have reduced run-off and soil erosion compared with conventional plots with a positive effect on crop production. The observation that farmers in the poor and medium wealth groups gave more importance to the soil and water conservation function of EMPFTs than rich farmers did could be related to the relevance of fodder trees for farmers that lack resources to purchase external inputs to maintain soil fertility.

Besides alleviating feed shortage, amongst the objectives of development organizations while introducing EMPFTs was to serve as fuel so that the manure would be saved from being used for fuel. However, in the present study their contribution to replace manure and their positive effect on crop production was insignificant in all districts and wealth groups. Similar results were reported by Neupane et al. (2002) in Nepal stating that only 18% of respondents perceived agro-forestry technologies improved crop yields. By the same token, Franzel et al. (2003) in central Kenya ascribed that the contribution of Calliandra for fuel wood was appreciated by only 24% of respondents, which was associated with the frequent pruning for feed that reduce the stem and trunk length and thickness that are important for burning qualities.

Fodder tree resources and management

Majority of respondents were dependent on external sources of seeds/seedlings to resume EMPFT development. Even after parent stock establishment, only a minority of respondents were capable of multiplying seedlings. The endeavour to rely on their own or community based seed and seedling exchange system was lower than in the Kenyan highlands reported by O'Neill et al. (2001) and Franzel et al. (2003), which may be attributed to the difference in the scale of dairy development and extension approaches in the two countries. The average initial age of cutting and annual cutting frequency recorded was similar to on-farm study reports in Kenya (Paterson et al. 1998; Franzel et al. 2003). Rich farmers were able to cut and start feeding at earlier fodder tree age than other wealth groups. The reason could be their higher number of fodder trees and better fodder tree management. The difference among districts in frequency of cutting may be related to the difference in moisture regime and feeding practice.

Constraints to adoption and implications

In Lay-Armachuho and Sidama districts where local multipurpose fodder trees are available, the lower multi-functionality of and more agronomic problems associated with EMPFTs were important reasons for low adoption. Also the observation that a high proportion of non-adopters and discontinued adopters preferred local multipurpose fodder trees to EMPFTs could be associated with a lower appreciation of multifunctional values of EMPFTs if compared to the alternative local sources. Napier and Napier (1991) argued that rural farmers will tend to choose development activities that offer at least as much, in terms of socio-economic and environmental benefits as they get from alternative activities. Use of local multipurpose fodder trees, when available, could therefore be an option for development of fodder tree use at farms.

The success of technology transfer also depends on the compliance of the technology with farm objectives. Development organisations tend to work on technology transfer on assumption of market integration of farmers, which in turn implies a production orientation with specialized farms and farmers that reason and decide on basis of economics to maximize their farm output. From the present perception study it seems justified to conclude that farmers used fodder tree supplementation not with the aim to achieve maximal livestock output. As stated earlier, it remains unknown whether adoption and maximal utilization of EMPFTs for animal production is limited by farm characteristics as land size and perceived agronomic problems, by the fact that livestock output is not the principal farm objective or by lack of knowledge among farmers. The observation that number of crossbreds at a farm related to the number of trees indicates that farmers with income from milk supplement more fodder tree biomass. In addition, in Sidama livestock is only a secondary farm component besides the growing of coffee. Farmers there grow EMPFTs also for the purpose of shade for coffee and have fewer trees per farm. However, farmers express the interest to develop the growing of fodder trees, which indicates that they do see beneficial effects for their farms, which relates to the appreciation they had for feed and soil and water conservation value of EMPFTs. Hence, farmers do take the effect on animal production into account which implies that perceived constraints as given in Table 7 could well be the limiting factors for adoption and growing more EMPFTs. Part of the constraints (agronomic problems, lack of utilization awareness) can potentially be overcome by participatory technology development and training and education of farmers. However, other constraints (low multipurpose values of EMPFTs, land and labour shortage, free grazing) are constraints that stem from the farming system itself and need to be approached through a problem analysis of the whole farm in which farmers should participate. The farm objective (whether subsistence, crop production or livestock output) will determine what farmers perceive as the most important problem to find a solution for. Only if exotic or local multipurpose fodder trees fit into the solution sustained adoption of fodder trees can be expected.

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