International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

The Effect of Under Sowing of Forage Legumes in Maize on Dry Matter Yield and Nutritional Value of the Fodder in Baresa Watershed, Ethiopia

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Abstract: ***A field evaluation study was conducted in Baresa watershed in Meskan Woreda, Gurage zone, Southern Nations, Nationalities and People Regional State, Southern Ethiopia in 2010. The objective of the study was to evaluate the effect of under sowing forage legumes in maize in terms of productivity, nutritional quality and compatibility. Three forage legumes namely cowpea (Vigna unguiculata), lablab (Lablab purpureus) and vetch (vetch dasycarpa) were under sown in maize (BH-540). The trial was laid out in a randomized completely block design with three replications on-farm, on three farmers field with participatory approach. The forage integration treatments did not have a significant effect on maize grain and biomass yield (P>0.05). There was no difference (P>0.05) among the different treatments in the chemical composition and the crude protein yield of the maize Stover. The DM yield of the legumes, total biomass yield varied significantly (P < 0.05) between treatments. Among the tested forage legumes, lablab produced the higher forage yield. The total fodder crude protein yield, varied significantly (p< 0.05) among treatments. Under sowing of forage legumes resulted in higher total crude protein yield than pure cropping of maize. High total crude protein yield was obtained in combination with lablab (0.94 t/ha) compared to maize pure cropping (0.60 /t/ha).The forage legumes crude protein yield, varied significantly (p. < 0.05) among treatments. From the legumes were under sown in maize the crude protein yield was higher from lablab (0.30 t/ha) compared to cowpea (0.19/t/ha). Under sowing forage legumes in maize is recommendable for high relative yield total, high total biomass yield and increased nutrient yield, particularly that of crude protein. Therefore, farmers are recommended to under sown lablab and/or vetch forage legumes in maize to enhance dry season feed availability in the Baresa watershed.***

Keywords: Under sowing, Forage legumes, Maize, Participatory, Nutritive value, Biomass

1. Introduction

Livestock keeping is an important component of the Ethiopian agriculture (Getnet and Inger Ledin, 1999). In Baresa watershed, similar to other part of the country, livestock play an important role in livelihoods of rural people. However, the livestock production is constrained by feed shortage in terms of both quantity and quality and also it is characterized by food insecurity, land degradation, land shortage and poor soil fertility (Tewoderos *et al.*, 2007). Due to rapidly increasing human population pressure, cropping is expanding and grazing areas are shrinking leading to a shortage of livestock feed. (Adugna, 2007) As a result animals are not able to satisfy their nutrient requirements and very often lose weight and productivity.

Maize is a dominant cereal crop in Baresa watershed and its area of production is increasing from time to time more than any other crop (Tewodros *et al.*, 2007). According to CSA (2008) report based on the area coverage and production in comparison to other crops, maize is the first major crops grown in the Baresa Woreda. A similar trend was reported for other areas of the country that the expansion of maize production in comparison to many other crops is increasing at high rate (Tesfaye *et al.*, 2001). As a result, the contribution of maize residues to animal feed resource is also increasing, specially, in early months of the dry season (Adugna *et al.*, 1990; Diriba *et al*., 2001). Challenges in their use of crop residues from the cereal fields as feed resource include their low nutrient density, digestibility and voluntary intake (Seyoum, 2007). This problem can be addressed to some extent by mixing crop residues with various forage legumes. This practice enhances rumen fermentation and the availability of energy from the total diet.

Several studies in Ethiopia showed that integration of forage legumes into the cereal cropping system can be used as alternative strategy for optimizing the productivity of a given land use system (Tothill, 1986; Adugna and Said, 1992; Mohammed-Saleem and Otsyina, 1996). Forage legumes can enhance soil fertility, protect the soil from erosive rains, improve yields and nutritive value of harvest product, sustain food and feed production (Mohammed-Saleem, 1985; Garba and Renard, 1991; Alemayehu, 1997). Integration of legumes into existing farming system enables to use land efficiently, to increase feed production and to maintain soil fertility.

So far, there is no information of the effect of under sowing of forage legumes in maize on dry matter and nutritional value in Baresa watershed. This study, therefore, was designed to evaluate the effect of under sowing forage legumes in maize in terms of productivity, nutritional quality and compatibility in maize to improve livestock feed supply in Meskan Woreda, Gurage zone, Southern Nations, Nationalities and People Regional State (SNNPRS), Southern Ethiopia.

2. Materials and Methods

2.1 Characteristics of the study area

The study was conducted in Baresa watershed, Meskan Woreda of Gurage Zone in Southern Nations, Nationalities and Peoples Regional State (SNNPRs), Ethiopia. The watershed is sited at $38^0 22^`$ E and $8^0 07^`$ N about 180 km east

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of Hawassa the capital city of SNNPRs or 138 km west of Addis Ababa, capital city of Ethiopia, at an altitude range between 1964 and 2200 meter above sea level. Topography is characterized by steep, undulating slopes divided by v-shaped valleys of seasonally intermittent streams and characterized by clay silt in soils texture and with p^H value of 6.3. The small rainy season (belg) extends from middle March to April while the main rainy season (meher) extends from June to early October. The month of July and August receive the highest rainfall and cause soil loss. In when this experiment was conducted, the annual rainfall was 1029 mm. However; there is a marked year to year fluctuation in the pattern of rainfall distribution. The average annual minimum and maximum temperature of the watershed were 14 ^{o} and 24 ^{o}, respectively. The watershed is characterized by food insecurity, land degradation, feed shortage, land shortage and poor soil fertility.

2.2 Selection of participating farmers and land preparation

The under sowing field experiment was conducted on-farm on three farmer fields at Baresa watershed in 2010. The farmers were selected in collaboration with agricultural development agent working on forage development in the Baresa Bureau of Agriculture and also from farmer's research groups. Those farmers research group selected by the community during participatory rural appraisal survey conducted by the operational research team in 2006 were working on the development activities with the objective of improving food security. The selection criteria were based on the farmer's interest, availabilities and accessibility of land and innovativeness of the farmers in the community. Selected farmers in the watershed were grouped into three categories based on the topography of the land on which the farmers were allocated, from top, middle and bottom landscapes in the watershed.

2.3 Estimation of the quantity of available feed resource

The quantity of feed resource in the stud area was estimated using the information on crop production and land area collected from the respondents. Besides, Secondary data on the area of the land cultivated by annual and perennial crops and the amount of grain produced was collected from the Woreda Agricultural Bureau and *Kebeles* annual report to augment primary data. The amount of crop residues and by-products that are used as source of animal feed was estimated using established conversion factors/multipliers developed by different researchers. The multiplier developed for wheat, barley and teff straw is 1.5 per unit weight grain yield, while the factor for maize and haricot bean are, 2.0 and 1.2, respectively (FAO, 1987; Adugna, 1990). The dry matter (DM) output of grazing pasture was estimated based on FAO (1987) multiplier factor, which is 2.0 tons/ha. Crop aftermath grazing potential was estimated by using a mean of 0.5 tons per hectare.

2.4 Experimental design and treatments

The trial was laid out in a randomized complete block design with three replications. The treatments were replicated on every farmer's field. Open pollinated maize variety, BH - 540 was planted in sole crop and as inter crop with three annual forage legumes; lablab (*Lablab purpureus)*, cowpea (*Vigna unguiculata)* and vetch (*Vicia dasycarpa)* were under sown in the maize. All the legumes and the maize were also planted in pure stands. Each treatment was planted on a plot size of 3.75 m * 3 m (11.25 $m^{2)}$. Descriptions of the treatments used in the study are given below in Table 1.

Table 1: Description of the experimental treatments used in the study

Treatments	Description
T_1	Vetch under sown in maize
T_2	Cowpea under sown in maize
T_3	Lablab under sown in maize
T_4	Pure stand maize
T_5	Pure stand vetch
T_6	Pure stand cowpea
T_7	Pure stand lablab

2.5 Sowing methods, crop management, seed and fertilizer rate

Maize variety, BH - 540 was planted at first in rows at the rate of 25 kg/ha. Spacing between an intra and inter-rows of maize were 25 cm and 75 cm respectively (Diriba *et al.*, 2001). The fertilizer rate was 100 kg/ha Di-ammonium Phosphate (DAP) at planting and 50 kg/ha urea was dressed at the stage of knee height of maize. The forage legumes were under sown when the maize reached knee height. At this stage the plots were hoed and the forage legumes were they broadcast in rows between maize rows. The pure stand annual forage legumes were sown at the rate of 30 kg/ha while the intercropped forage legumes were sown at half the normal seeding rates. All important agronomic data such as plot cover, plant height, ears per plant, total maize population, vigor, weeding date were taken and incidence of pests and disease were checked until the time of harvesting.

2.6 Harvesting

Harvesting of the maize plants was done at 150 days after planting (with moisture contents in the grain ranging from 24% to 31%), maize plants from the middle two rows were cut 12 cm above the ground level; and maize ears and maize residues were partitioned and weighed in the field to determine biomass yield. Grain yield was determined following shelling and adjusting the moisture level to 12.5 %. Forage legumes from the under sown and pure stand plots were also cut at the same height at about 10 % flowering to determine biomass yield of legumes. Sub samples from maize residues and forage legumes was dried in forced draft oven at 65^{o}C for 72 hours (Seyoum *et al.*, 2007) and weighed. After weighting sub samples of maize and legumes were grained to pass through 1mm sieve size for chemical analyses and digestibility determination.

2.7 Biological compatibility and dry matter yield advantage

The relative yield describes the response of a particular species to the competition imposed by another species in a mixed stand. The sum of the relative yields of species has

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been defined by De Wit and Vander Bergh (1965) as a relative yield total (RYT). The RYT describes the resource complementarities between species in a binary mixture the value assumed by this index indicates whether the species are performing better in a mixture than in mono-culture. Three situations can be identified; RYT =1, RYT>1 and RYT<1, respectively indicating the absence of biological yield advantage, complementarities in resource use between the two species and the highly aggressive nature of one of the components to the extent that one species poisons the other.

2.8 Farmer's participation and evaluation of the forage development technologies

Farmer's were involved in all stage of activities from site selection, land preparation, planting, managing the trial and harvesting to evaluation. Field day was organized by operational research project, which was working in the study area to increase awareness on integrated natural resource management in the community. Key informants and development agents evaluated the planted legumes and selected legumes which were more compatible when under sown in maize by using their own criteria.

2.9 Statistical analyses

Survey data**,** descriptive data was analyzed using SPSS statistical package and experimental data , Analysis of variance was carried out using the General Linear Model (GLM) procedure of SAS (Statistical Analysis System) software and Duncan's multiple range tests was employed for separation of means (SAS, 2001). The following general model was used for analysis: $Y_{ij} = \mu + b_i + t_j + e_{ij}$, where Y is the measured response, μ = overall mean, b_i = block effect, t_i treatment effect, and e_{ij} = the random error.

2.10 Chemical analysis

Forage samples from the under sown forage legumes in maize were collected and analyzed for their nutritive value. Total ash was determined by igniting the sample in a muffle furnace at 550°C for six hours. (Seyoum *et al.*, 2007) Nitrogen (N) content was determine by micro-Kjeldahl method and crude protein (CP) content was calculated as N * 6.25 (Seyoum *et al.*, 2007) Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined according to the procedures of Van Soest and Robertson (1985). Hemi-cellulose content was calculated as NDF – ADF. Dry matter digestibility was determined using the modified Tilley and Terry (1963) *In vitro* techniques (Van Soest and Robertson, 1985).

3. Results and Discussion

3.1 Improved Forage Production

There were little adoption and availability of improved forage crops grown in the watershed, which is introduced by the Operational Research Project in collaboration with the Hawassa Agricultural Research Center and Woreda agriculture office. However, according to the respondents only 44.6% of the households planted improved forage crops; the remaining 55.4% of the households did not cultivate improved forage crops. Moreover, the proportion of land allocated for cultivated forage crops was too small, which is less than 1% of the total cultivated land of the area. According to respondents, the reason for not using cultivated forage crops in the study area in order of shortage of land, lack of awareness of farmers on benefits of cultivating forage crops and shortage of availability of forage seed and planting material in decreasing order of importance.

Different forage species such Elephant grass, V*icia dasycarpa*, *Sesbania sesban*, and *Cajanus cajan* have been tested and were found to be well adapted, productive and accepted by the farmers. In addition to the forage species various forage technologies such as hedgerow, backyard, soil band particularly associated with the natural resource conservation has been demonstrated.

However, the adoption rate of the forage technologies in the study area is found to be very low due to weak extension support, which mainly emphasized on food crops. There is generally less emphasis by research and extension on livestock and forage development. Forage development strategies such as hedges around field edges and on soil bunds, particularly on the sloping land, intercropped with the cereals and alley cropping have a chance of better acceptance by the community

3.2 Establishment and persistence

Cowpea fodder yield was lower in one of the trial farmer's field than on the other trials framers. The decline in plant population of cow pea was mainly due to pest attack and this farmer field found in the middle landscape of the watershed, form soil sedimentation that comes from hill top and covers the cropping land. The decline in population indicates a serious pest problem, and therefore suggests that disease and pest control in forages should be done for pest susceptible species to optimize yield and quality. Maize stalk borer and aphids were noted at about 4 weeks after planting. Spraying with the pesticide Carbonyl at the rate of about 14 liter per hectare effectively controlled the aphids in maize.

3.3 Intercropping and total yields

Maize grain, maize biomass yields, legume biomass and total forage biomass yields are given in Table 3. The effect of forage undesowing treatments on maize grain yield, maize biomass and maize plant height were not significant (P>0.05). Mean grain yield values and maize biomass ranged from 49 to 52.6 q/ha and 8.7 to 9 t DM / ha, respectively.

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Table 3: Grain and biomass productivity of maize in pure stands and when under sown with Forage legumes in Baresa watershed

No.	Treatments	Maize grain yield (q/ha)	Maize biomass (DM t/ha)	Legume biomass (DM t/ha)	Total biomass (DM t/ha)
1	Maize + Vetch	52.62 (7.4)*	8.95	1.90 [c]	10.84 [a]
2	Maize + cowpea	51.87 (5.9)	8.83	1.37 [c]	10.20 [a]
3	Maize + Lablab	51.47.(5.0)	8.78	1.99 [c]	10.77 [a]
4	Pure Maize	48.98	8.74	-	8.74 [ab]
5	Pure Vetch	-	-	6.98 [ab]	6.98 [b]
6	Pure cowpea	-	-	6.32 [b]	6.32 [b]
7	Pure Lablab	-	-	8.85 [a]	8.85 [ab]
	Mean	51.23	8.83	4.57	8.96
	SEM	3.59	0.57	2.64	0.52
	P level (0.05)	0.5996	0.9819	0.0001	0.0155

Means within a column with different superscripts are significantly different (P < 0.05)
* = % of increase maize grain yield due to under sowing of forage legumes in the maize

Under sowing of the forage legumes did not show significant effect (P>0.05) on grain yield of maize. However, compared to that of the pure stand maize, inclusion of vetch, cowpea and lablab increased grain yield of the maize by 7.4%, 5.9% and 5%, respectively. The findings were in agreement with Diriba *et al.* *(*2001); Alemayehu (2002), where inclusion of forage legumes increased grain yield of a companion cereals by 4.9 to 6.8 %. However, the results of this study are contrary to those reported by Aklilu *et al.* (2007); Lupwayi *et.al.* *(*1996) and Mpairwe *et al.* (2002) where inclusion of forage legumes depressed grain yield of companion cereals by 3.6 to 9%. The highest grain yield was obtained when maize is under sown with vetch (52.6 q/ha) followed by cowpea under sown plots (51.9 q/ha). The lowest maize grain yield was obtained when planted in pure stands (49 q/ha). The biomass yield showed also a similar trend in the order of vetch, cow pea, lablab and pure stand maize in declining order. Similar result was reported in previous studies (Diriba *et al.*, 2001; Alemayehu, 2002). This study shows that maize under sown with legumes gave the highest biomass and grain yield than pure stand maize possibly because, in addition to N-fixation, having good plot cove that may protect the soil from runoff water and lose of the top soil and increasing infiltration of water into soil which enhances the use of

Table 4: Chemical composition and *in vitro* dry matter digestibility of maize Stover grown in pure stands and when under sown with forage legumes

Parameter (g/kg DM)	**Treatments**					
	Sole maize	Maize with vetch	Maize with cowpea	Maize with lablab	SEM	P
DM	898	901	901	904	4.99	0.83
CP	69	73	72	72	1.29	0.59
NDF	737	733	733	729	7.64	0.86
ADF	474	452	457	453	13.90	0.77
Hemi-cellulose	263	281	276	276	6.65	0.88
IVDMD	546	550	548	548	2.11	0.77
OM	917	919	921	918	0.99	0.50

available nutrient for maize plant growth (Tilahun and Kirkby, 2004; Getnet *et al.*, 1991).In addition, under sowing helps in suppressing the growth of weeds. The result showed that relative yield ratio of maize was greater than one (Table 7.), indicating that the yield obtained in mixed stand were greater than those obtained from pure stand and suggesting yield advantages from the mixture treatments was complemented by legumes in nitrogen fixation and the more ability of competitiveness than legumes

The DM yield of the legumes and total biomass (maize biomass + forage legumes) varied significantly (P<0.05) among treatments. From the pure stand legumes, higher (p < 0.05) DM yield was recorded for lablab (8.85 t DM/ha) compared to cowpea (6.32 t/DM /.ha). The under sown forage legumes biomass yield for the three forage legumes were comparable (P > 0.05). Higher (P <0.05) total biomass yields were obtained from maize forage crop intercropped fields than maize pure cropping fields. Frequent field observation during the experimental period indicated that the significant reduction of the DM yield of cowpea was also attributable to the shading effect of the main crop (maize) and attack by the foliar disease, anthracnose that resulted in leaf shuttering and weak stands. The smaller DM yield obtained from sole cowpea plots puts the suitability of this system in question. Though the amount of fodder obtained from cowpea-maize base system was low, the fact that this yield was obtained without affecting maize grain yield and also preferred by participant farmers during evaluation due to its suitability to be used as a dual purpose crop (food and feed), which makes the intervention attractive.

3.4 Forage and Stover quality

There was no significant difference (P > 0.05) among the chemical composition content (DM, ash, CP, NDF, ADF and IVOMD) of maize Stover due to the effect of under sowing different forage legumes (Table 4). The crude protein content was not significantly different (P>0.05) in the Stover obtained from the different treatments. However, it showed a trend in the order of maize + vetch > maize+ lablab > maize + cowpea > pure stand maize. The CP content of maize under sown with forage legumes was the higher ranging from 72 to 73 g/kg/DM, while the CP content of Stover from pure stands was the lowest 69 g/kg/DM. In general, the CP content of most cereal crop residues is lower than critical level of microbial protein synthesis and then exists nitrogen deficiencies; the most important limiting factor in feed intake (Adugna *et al.*, 1999). While the CP content of maize under sown with forage legumes was above the critical level. This indicates that when maize under sown with forage legumes; it improves the quality of maize CP than pure stand maize.
DM = Dry Matter, CP = Crude Protein, NDF = Neutral Detergent Fiber, ADF = Acid Detergent Fiber, IVDMD = *In vitro dry* Matter Digestibility, OM = Organic Matter, P =.Probability (P = 0.05), and SEM = Standard Error of Means

On the other hand, the CP of pure stand grown maize variety (BH-50) used for this study had higher CP (69 g/kg/DM) than the value (28-61 g /kg/DM) reported in previous study by Adugna Tolera *et al.* (1999**),** on the selection of eight maize varieties on grain and residue and nutritive value of the stover. The chemical composition such as ash, CP, ADF, NDF, IVDDM, OM and hemi-cellulose content were not significantly different (P > 0.05) among the legume species.

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Table 5: Chemical composition and *in vitro* dry matter digestibility of forage legumes under sown in maize and grown in pure stands

Parameters (g/kg DM)	Legumes						P	SEM
	Pure stand legumes			Under sown legumes				
	Vetch	Cow pea	Lablab	Vetch	Cowpea	Lablab		
Dm	943	920	945	943	943	944	0.51	4.2
Ash	108	102	100	109	109	104	0.29	1.6
CP	136	172	151	147	158	155	0.16	4.8
NDF	361	338	338	380	364	345	0.09	8.5
ADF	313	304	291	334	321	306	0.10	5.2
Hemi-Cellulose	68	49	59	62	57	57	0.18	2.6
IVDDM	673	663	660	682	675	667	0.08	2.7
OM	892	877	898	891	890	898	0.77	3.4

DM = Dry Matter, CP = Crude Protein, NDF = Neutral Detergent Fiber, ADF = Acid Detergent Fiber, IVDMD = *In Vitro* Dry Matter Digestibility, OM = Organic Matter, P =.Probability (P.0.05) and SEM = Standard Error of Means.

3.5 The crude protein yield

The crude protein yield of maize Stover, forage legumes and total fodder are given in Table 6. The total fodder (maize Stover + legumes) crude protein yield, varied significantly ($p < 0.05$) among treatments. Under sowing of forage legumes resulted in higher total CP yield than pure cropping of maize. From maize based mixed forages, high total crude protein yield was obtained in combination with lablab (0.94 t/ha), vetch (0.92 t/ha), and cowpea (0.83 t/ha compared to maize pure cropping (0.60 /t/ha).The forage legumes crude

Protein yield, varied significantly ($p < 0.05$) among treatments. From the legumes were under sown in maize the CP yield was higher from lablab (0.30 t/ha) compared to cowpea (0.19/t/ha). The maize Stover crud protein yield was not significantly different ($p > 0.05$) among treatments. However, the CP content of maize under sown with forage legumes was the highest ranging from 0.63 to 0.65 t/ha, while the CP yield of Stover from pure stands maize was the lowest 0.60 t//ha.

Table 6: Crude protein yield of maize Stover, legumes and total fodder grown in pure stand and when under sown with forage legumes

No.	Treatments	Crude protein t/ha		
		Maize Stover	Legumes	Total
1	Maize + Vetch	0.65	0.27^a	0.92^a
2	Maize+ Cowpea	0.64	0.19^b	0.83^a
3	Maize + Lablab	0.63	0.30^a	0.94^a
4	Pure Maize	0.60	-	0.60^b
	Mean	0.63	0.19	0.82
	MSE	0.05	0.08	0.09
	P. level	0.62	0.0015	0.0015

Means within a column with different superscripts are significantly different ($P < 0.05$)

Relative yield ratio of forage legumes under sown in maize

Maize relative yield ratio (MRY), forage legume relative land equivalent ratio (FRY) and relative yield total (RYT) are given in Table 7. The relative yield ratio of forage legumes were less than one indicating that the yield obtained in pure stands were greater than those obtained from mixed stand, and have no any herbage yield advantage. This may suggest the longer growing period and fast growth rate of maize and shorter growing period of forage legumes, which affected the total forage legume biomass yield. The relative yield of maize was greater than one indicating that the yield obtained in mixed stand were greater than those obtained from pure stand and suggesting yield advantages from the mixture treatments which was complemented by legumes under sowing and the more ability of competitiveness than legumes The mean value of relative yield total were for all greater than one implying the presence of some yield advantage from the mixture treatments This suggests that the two species were not strictly competing for the same growth factor. The higher yield advantage of 46, 44 and 36% were obtained from the vetch, lablab and forage crops cowpea under sown in maize, respectively.

Table 7: Relative yield ratio (RY) and relative yield total (RYT) of forage legumes under sown in maize and grown in pure stands

Treatments	Relative yield ratio(RY)		Relative yield total (RYT)	Yield Advantage (%)
	Maize	Legumes		
Maize + Vetch	1.067	0.392	1.46	46
Maize + Cowpea	1.060	0.302	1.36	36
Maize + Lablab	1.012	0.430	1.44	44
Mean	1.05	0.37	1.42	
SEM	0.0117	0.038	0.054	
P - level (0.05)	0.75	0.66	0.83	

3.6 Reaction of participating farmers to the technology

The reaction of participating farmers in terms of the advantages and drawbacks of the technology compared to the local practice (monoculture) whether the undesowing forage legumes in maize crop solved the problem of land, soil fertility and shortage of animal feeds or not were assessed. Cross visits were made at early stage, at harvest and post harvest, and training on forage planting; harvesting and utilization were given to participants and key innovative farmers on the field. Participant farmers, farmer's research group, Baresa Woreda Office of Agriculture and Rural Development (BWOAD), site Development Agents (DAs), from other community's farmers and researchers evaluated the trial. There was increased realization on the part of researcher and extension personnel that the technology became effective and acceptable by the farmers when the farmers themselves are involved in the research program. It also benefited the researchers in gaining and understanding of farmer's evaluation criteria and created good opportunity to communication with farmers. It gives the farmers also a lesson that they have to give as much attention to forage crops as the food crops. Therefore, field day is important source of information on integrated watershed management in Baresa and serves as experience sharing, dissemination of available technologies; it is generally, used for awareness creation on forage development strategies in integrated way and promotes the adoption of improved forage technologies to study areas. In addition, the participant farmers and key innovative farmers of the community cross-visit their trial were critically evaluate forage trial based on their criteria's.

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The farmers of two *kebeles* in the watershed used almost the same criteria of evaluation and even the same type of forage species was selected. Farmers major criteria considered in the evaluation of forage species were vegetative growth, herbage yield, growing habit for protection of soil erosion, palatability, performance under dry weather condition, multipurpose use, improvement of soil fertility by looking soil color under forage crop planted and compatibility in maize crop and fast growing etc. (Table 8). However, farmers evaluation criteria depend only on visual assessment but nutritional value that have not been included in the evaluation criteria , which is indicator of over all performances (CP t/ha) of forage yield.

Some farmers already had experience with vetch and cow pea in Baresa and they have no questions on palatability by livestock. Generally, all participating farmers were very much impressed and interested to grow the forage in the watershed after they have realized the good establishment and performance of the forage varieties, especially vetch under sown in maize. They also understood that one can produce forage crops by under sowing without competing land for crop production. In the future farmers promise to widely distribute promising legume crops into farming system in collaboration with the Woreda office of agriculture. Hollington (2004) reported the interest of the farmers in the forage development in the watershed was clear to all staff, and they recognized that they would have to make efforts to ensure farmers did not become disillusioned.

Table 8: Farmer's rating and criteria for selection of forage legumes under sown in maize (Best = 4 and least preferred = 1) and Number of evaluating farmers =56

Evaluation parameters	*Maize. +.Vetch*	*Maize + Cowpea*	*Maize + Lablab*
Vegetative growth	4	4	3
Herbage yield	3	2	4
Multi-purpose use as food & feed	3	4	3
Protection of soil	4	3	2
Palatability	4	3	3
Drought tolerance	3	4	3
Computability with maize crop	3	4	4
Maintenance of soil fertility	4	3	3
Fast growth	4	3	2
Total score	32	30	27
Rank	1st	2nd	3rd

Farmers evaluated the performance of forage crop experiments and voted for vetch, cowpea and Lablab under sown in maize, respectively as it performed well under both tested farmers *kebeles* of Baresa watershed. However, farmers considered other selection criteria's equally as forage biomass production.

4. Conclusion

Total biomass yields of maize intercropped with forage legumes were significantly higher than pure stand maize, with yield ranging from 6.3 to 10.84 t/ha DM. Changes in nutrient quality of forage were more pronounced in cereals-legume intercrops than in pure cropped maize. However, persistence and growth of some forages, particularly cowpea were affected by the growth habit and diseases and pests. Thus, cowpea use in the study area as forage may be limited by susceptibility to pests. Though the amount of fodder obtained from cowpea-maize base system is low, the fact that this yield is obtained without affecting maize grain yield makes the intervention attractive.

According to the finding of this study on quantity and nutritional values, in the Baresa watershed the ranking order of the forage legumes was lablab, vetch and cowpea in a decreasing order. They were well adapted, highly productive and compatible in maize. In general, those tested forage crops have potential to be used for forage production at Baresa watershed, through under sowing or in pure stands. However, the preferences of farmers was higher for vetch, followed by cowpea and lablab in that order due to their rational preference for well known (vetch) and dual purpose (cowpea) forage than new comer species (lablab). The selection criteria of farmers were far beyond biomass production. They were considered other selection criteria's equally as forage biomass production. Generally, all participating farmers were very much impressed and interested in the forage development strategy like under sowing of forage legumes in maize crops to solve animal feed shortage, land shortage and improve soil fertility to ensure crop productivity and sustain food security in the study area.

5. Future Opportunities

Overall, the study showed that there is high potential for enhancing the integration of food and forage crop production on small-holder mixed farms through production of leguminous forage that are compatible in the existing farming system. The study also demonstrated the available forage technologies to the community through participatory approach to create awareness on the forage production and possibility of increasing the adoption rate of forage crops to obtain high quantity and quality feed in the watershed. Under sowing forage legumes in maize is recommendable for high relative yield total, high total biomass yield and increased nutrient yield, particularly that of crude protein. Therefore, farmers are recommended to under sown lablab and/or vetch forage legumes in maize to enhance dry season feed availability in the Baresa watershed.

The following points are recommended for future research and development directions based on the findings of the present study:

- In addition to introduced materials, other legume species should be tested for adaptation and production in integration with different food crops
- Focus on forage development strategies that fit into the existing farming system without too much competition with food and cash crops produced by the farmers.

6. Acknowledgements

Numerous individuals and groups have been instrumental in the conduct of our research and make the result ready for use. First of all, we would like to acknowledge development agents of the Baresa watershed who made the research to bear fruit. Their participation, hospitality and household survey we also thank the Southern Agriculture Research

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Institute (SARI) for their co-operation and praiseworthy support and back-ups in many ways and Operational Research Project for financial support.

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