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Participatory Evaluation and Demonstration of Maize Forage Intercropping Practice at Adami Tulu Jiddo Kombolcha District, Central Rift Valley of Oromia, Ethiopia

Tesfaye Gemechu*
Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center
Email: gtesfaye3@gmail.com

Hikma Sultan
Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center
Email: hikmeshsultan@gmail.com

Abstract
An intercropping practice of maize with forages were evaluated and demonstrated at Adami Tulu Jiddo kombolcha district of East shoa zone with the participation of farmers in collaboration with district office of agriculture. The objectives were to to create awareness on maize forage intercropping, to evaluate grain and biomass yield of the intercropped maize and forage varieties under farmers condition, to analyze the cost-benefit of the demonstrated practices and to assess farmers' and other stakeholders' feedbacks for further technology development/improvement. The results indicated that the forage intercropping practice have no significant effect on maize yield. Numerically better yield was obtained from sole maize (62.23qt/ha) followed by Maize intercropped with lablab (61.45qt/ha). Maize intercropped with cowpea gave the least maize grain yield (55.2qt/ha). However, the forage intercropping practices gave more than 4 ton/ha of forge biomass yield without significantly affecting the yield of Maize crop. Furthermore, intercropping maize with Lablab weighed better than intercropping maize with cowpea in terms of its grain yield, dry matter yield as well as financial performance. Therefore, further wider scaling up works on Maize lablab intercropping is recommended.
Keywords: Intercropping, Pre-extension Demonstration, forages, rift valley
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1. Background and Justification

Continuous increase in the world population, particularly in the eastern Africa region has increased the demand for food significantly. As a result arable land is mainly devoted for food crops production. Even though animals are very important in agricultural production in the tropics, limited land is given for forage production (Whiteman, 1980). Thus, natural pasture has been the main livestock feed source. Furthermore, grazing lands are under cultivation to satisfy the need of increasing human population.

In view of this, the present system of sole cropping practice cannot meet the diversified needs of the small scale farmers. In addition, due to the limited land available for food crop production sole forage production is not feasible in mixed crop livestock production system whereby food crop production is given high priority. Therefore it is very important to seek alternative forage production strategies for different areas. This is where intercropping comes handy. Intercropping is the agricultural practice of cultivating two or more crops/forages in the same space at the same time which aims to match efficiently crop demands to the available growth resources and labor. The most common advantage of intercropping is the production of greater yield on a given piece of land by making more efficient use of the available growth resources using a mixture of crops of different rooting ability, canopy structure, height, and nutrient requirements based on the complementary utilization of growth resources by the component crops.

In central rift valley areas, in general and in Adami Tulu Jiddo Kombolcha district in particular food crop production is given high priority and the farming system is mixed crop livestock production system. In the district maize is the dominant crop under production. Farmer practice intercropping of maize and haricoat been but intercropping maize with forages is not yet practiced. Yet feed shortage is a critical problem in livestock farming in the study area and crop productivity is low compared to other areas. Thus, to improve crop productivity aw well as to increase feed in quality and quantity, efforts must be done by introducing best combining forage legumes species into existing cropping systems through intercropping (Daniel, 1996).

To this end, experiments emphasizing on intercropping of maize with forages have been conducted and promising results have been found (Diriba Geleti and Lemma Gizachew 2003, Gbaraneh et al., 2004). According to the studies, intercropping maize with forages there had no significance yield reduction. Rather producers can obtain additional forage biomass. Therefore, in the areas where maize is major crop and animal feed shortage is critical, intercropping forage legumes with maize will produce additional biomass and contributes to improving

livestock feed availability.

Therefore, this activity was proposed with the following objectives

2. Objectives

- To create awareness on maize forage intercropping
- To evaluate grain and biomass yield of the intercropped maize and forage varieties under farmers condition
- To analyze the cost-benefit of the demonstrated practices
- To assess farmers' and other stakeholders' feedbacks for further technology development/improvement

3. Methodology

3.1. Description of the study areas:

The study was conducted in selected district of East Shewa zone. East Shewa zone is one the administrative zones of Oromia regional state, Ethiopia. The zone has an area of 10241km2and Adama town is serving as the capital town of the zone. There are 10districts within the zone among which Dugda and Lume districts are the study districts where this demonstration activity took place

Adami Tulu Jido Kombolcha district is located at 160 km from the capital city of Ethiopia, Addis Ababa and 115 km from Oromia region's and East Shewa's zonal capital Adama. The district lies at latitude of 7.58ºN and 38.43ºE longitudes. Its altitude ranges from 1500 to 2300 meters above sea level. The mean annual rainfall ranges from 750- 1000mm and the distribution is highly variable between and within years. The mean annual temperature ranges from 22-280C. Mixed crop livestock farming system characterizes the agriculture of the district. The major crop produced under rain fed agriculture is maize.

3.2. Site and farmers selection

The study was conducted for two consecutive years at Adami Tulu Jido kombolcha district on two selected kebele's. Thirteen trial farmers were selected from each kebele based on their willingness to involve in the study and who engaged on both crop and livestock production. In each Kebele one group was organized using FREG approach having a total of 21 members considering the participation of women. Thus a total of two groups having 42 members was organized. The selection of sites, FREG organization and trial farmers' selection was done in collaboration with experts from district office of agriculture and natural resource and development agents residing at Kebele level.

3.3. Capacity Development

Training has been provided for all FREG group members, development agents and Experts on forage production, management and cattle feeding. Furthermore, field days were organized to create awareness on the intercropping practice to involved stakeholders.

3.4. Planting materials used

One locally adapted variety of maize BH-540, one variety of Cowpea (Black Eye Bean (BEB)), and one lablab variety were used. The forage varieties are adapted varieties to the study location.

3.5. Field design and treatments

The demonstration fields used was a total of 0.25ha per trial farmer. Land preparation was done by ox power. A spacing of 7cm between rows and 25cm between plants was used to plant the maize. The forages were sown 15 days after maize was planted as intercropping in between the maize row with 20cm between plants. Other agronomic practices were applied as per recommendations.

3.6. Treatments:

The crops were planted on each farmers land for comparisons as

T1: farmers practice: sole maize
T2: intercropped maize and cowpea
T3: Intercropped maize lablab

3.7. Data to be collected

- Grain yield, biomass yield, costs involved and benefits gained and farmers feedbacks were collected

3.8. Data analysis

The collected yield data was analyzed using SPSS V20 software. Descriptive statistics mainly mean was used to analyze the grain and biomass yield. Other quantitative gender disaggregated data were described using tables.

Farmer feed backs were summarized qualitatively and described using tabular presentations.

4. Result and Discussion

4.1. FREG formation and training

Before planting training was provided for all participating farmers including host and non-host/ follower farmers, DA's and district experts. A total of 42 farmers, 6DA's, 2 Experts and 16 other stakeholders including researchers were participants of the training

Table 1: Number of groups formed and farmers and other participants trained

No of Groups	Total no of farmers	No of training participants									
		Farmers		DA's		SMS		Others		Total	
		M	F	M	F	M	F	M	F	M	F
2	42	34	8	4	2	2	0	14	2	54	12

4.2. Yield Performances

The intercropping practices were compared in terms of their maize grain yield and dry matter biomass performances. Accordingly no significantly differing yield and Dry matter performances were gained.The following table describes the result.

Table 2. Yield performance comparison of maize forage intercropping practices

Practices	**Maize Grain Yield (Qt/ha)**			**Forage DM yield (t/ha)**		**Sig. level (p<0.05)**
	N	GY	Std. Deviation	DM yield	Std. Deviation	
Maize only	13	62.23 ± 3.97503	14.33217			
Maize Cowpea	13	55.2 ± 4.47862	16.14790	4.1977 ± .76	2.72140	Ns
Maize lablab	13	61.45 ± 5.22463	18.83768	4.4346 ± .97	3.48835	

N.S: Non significant

According to the result presented on the table above, numerically better yield was obtained from sole maize (62.23qt/ha) followed by Maize intercropped with lablab (61.45qt/ha). Maize intercropped with cowpea gave the least maize grain yield (55.2qt/ha). However, both intercropping practices gave more than 4 ton/ha of forge biomass yield without significantly affecting the yield of Maize crop. The findings of this demonstration activity are in line with the findings of (Dawit and Nebi 2017), Getachew 2013, Diriba Geleti and Lema Gizachew 2003, Gbarneh et,al. 2004) where compatible species of forages intercropped with maize can give better biomass without significantly affecting the yield of the maize crop.

4.3. Financial analysis

To estimate the income gained through the intercropping practice a simple financial analysis has been done. The calculations were done on hectare bases taking the market price at harvesting time. The variable costs of the input purchase were the prices during at the early production (rainy) seasons. The calculations also considered price of land (4000 ETB/season) as a fixed cost considering the practice of renting land in the study area. Accordingly, the results indicate that a farmer can get an income of 68,150 through producing sole maize, while for intercropping maize with cowpea an income of 59,750 was gained by allocating a ha of land. According to the calculations the highest income can be gained through intercropping maize with cowpea; which is 68,996 Ethiopian birr.

Table 3. Financial analysis on maize forage production 2013 rainy season, Adami Tulu Jiddo Kombolcha

Location: Adami Tulu Jiddo Kombolcha district, Oromia, Ethiopia				
Parameters (on hectare bases)		Intercropping practice		
		Sole maize	Maize cowpea	Maize lablab
Grain Yield (maize (Y) qt/ha		62.23	55.2	61.45
Price (P) per quintal (Birr)		1500	1500	1500
Total Revenue maize (TR= YxP)		93,345	82,800	92,175
Forage biomass yield (t/ha)		0	41.2	44.3
Price for forage biomass(P) per quintal (Birr)		160	160	160
Total Revenue forage biomass (TR= YxP)		0	6592	7088
Total revenue of the practice (TR= YxP)		93,345	89,392	99,263
Variable costs	*Seed cost*	836	5786	5786
	Fertilizer cost	3425	3425	3425
	Chemicals	3511	3511	3511
	labor cost	3000	3000	3000
	Threshing cost	6223	5520	6145
	Transportation cost	200	400	400
Total variable costs (TVC)		17,195	21,642	22,267
Fixed costs	Cost of land (If rented)	4000	4000	4000
Total fixed costs (TFC)		4000	4000	4000
Total Cost (TC) = TVC+TFC		21,195	25,642	26,267
Gross Margin (GM) = TR-TVC		72,150	63,750	72,996
Profit= GM-TFC		**68,150**	**59,750**	**68,996**

4.4. Field days

Field days are means of communicating out-put and creating awareness about improved technologies or practices leaving participants specially farmers with new interests and new concepts of what is possible after seeing what their FREG members have been able to accomplish in their line of work. To this end, in this large-scale demonstration activity field day was used as a means to create awareness about the intercropping practice. , method of production as well as the forage production. Thus, a total of 96 Participants attended field day in the course of implementing the activity.

Table 4: number of field day participants and their role

No of field days conducted	No of participants									
	Farmers		DA's		SMS		Others		Total	
	M	F	M	F	M	F	M	F	M	F
2	58	14	4	2	2	0	14	2	78	18

4.5. Farmers' feedback

The FREG member farmers were let to observe the performance of the three practices at different growth phases through different visits. The practices demonstrated were compared based on farmers' preferences, qualities and their drawbacks raised by farmers and presented in the following table. The participant farmers preferred maize lablab intercropping as their first choice when compared to other practices.

Table 5: Farmers feedback on good qualities and drawbacks observed during the scaling up phase

Practices	**Rank**	**Reasons**
Maize-lablab intercropping	1	Very good grain as well as biomass yield without affecting yield, Good plant height and biomass, covers the space very well
Maize-cowpea intercropping	2	Lower grain and biomass yield, lower plant height and biomass cover

5. Conclusion and recommendations

The demonstration activity created an opportunity for farmers to evaluate the performance of intercropping forages with maize.

Furthermore, through the trainings and field days, awareness has been created to the participating farmers on how to produce and feed forages for their cattle's without affecting their main crop. As a result, the intercropping

practice of forages with maize was found to be important in enhancing the participating farmers forage productivity. The results indicated that the forage intercropping practice have no significant effect on maize yield
Yet, intercropping maize with Lablab weighs better than intercropping maize with cowpea in terms of its grain yield, dry matter yield as well as financial performance. Therefore, further wider scaling up works on Maize lablab intercropping is recommended.

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