Evaluation of sorghum/faba bean intercropping for intensifying existing production systems

Reducing Land Degradation and Farmers' Vulnerability to Climate Change in the Highland Dry Areas of North-Western Ethiopia

TECHNICAL REPORT OF EXPERIMENTAL ACTIVITIES

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Implemented by

ICARDA
Science for Better Livelihoods in Dry Areas

In collaboration with

ARARI

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Funded by

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About the Project

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About ICARDA

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Synthesis

Activity type: Technology generation

Report submitted by: Tsedalu Jemberu

Schematic summary of information

Location (locality, town, province…..)	Gumara Maksegnit watershed
Easting:	3°45'80.0"
Northings:	13°73'90.8"
Elevation	2003m a.s.l.
Period of implementation (date … to ….date)	January 2013 to April 2015
Duration of trials (n. of years; n. of seasons)	Two years
Activity leader(s) with email address	Tsedalu jemberu (tsedalu2009gmail.com)
Other researchers involved	Wondimu bayu (PhD), Yimer Abje and Tesfaye Jorgi
Technical staff involved	

1 Background and rationale

Intercropping, the growing of two or more crops simultaneously on the same field at the same time, is an old and commonly used cropping practice 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 (Lithourgidis et al., 2011; Rezaei-Chianeh et al., 2011; Tilahun et al., 2012). Moreover, intercropping improves soil fertility through biological nitrogen fixation with the use of legumes, increases soil conservation through greater ground cover than sole cropping, and provides better lodging resistance for crops susceptible to lodging than when grown in monoculture (Lithourgidis et al., 2011). Intercrops often reduce pest incidence and improve forage quality by increasing crude protein yield of forage. Intercropping provides insurance against crop failure, especially in areas subject to extreme weather conditions such as frost, drought, and flood. Thus, it offers greater financial stability than sole cropping, which makes the system particularly suitable for labor-intensive small farms. Besides, intercropping allows lower inputs through reduced fertilizer and pesticide requirements, thus minimizing environmental impacts of agriculture. However, intercropping has some disadvantages such as the selection of the appropriate crop

species and the appropriate sowing densities, including extra work in preparing and planting the seed mixture and also extra work during crop management practices, including harvest. The selection of an appropriate intercropping system for each case is quite complex as the success of intercropping systems depend much on the interactions between the component species, the available management practices, and the environmental conditions. The amount of cultivable land is gradually decreasing, mainly because of rapid population explosion. The limited land areas are facing pressure to meet basic demands, especially for food, fiber and oil since most growers own very small plots of land. In view of this, there is need for not only increased production, but also the ability to grow multiple crops in small areas. Furthermore, the sorghum variety grown in the watershed stays in the field for more than six months and the growth of the variety is very slow and has very poor canopy coverage until September which would lead to soil erosion and aggressive weed growth. This opportunity could be utilized to introduce an intercrop which would enable to efficiently utilize the land efficiently and to reduce soil erosion. Therefore, this study was initiated to evaluate the productivity of sorghum/faba bean intercropping under the Vertisols of Gumara-Maksegnit watershed.

2 Objective

The main objective of this research activity was to evaluate the productivity of sorghum/faba bean productivity and to determine the best sorghum/faba bean combination.

3 Experimental Methods

The experiment was conducted at Gumara-Maksegnit watershed in 2013 and 2014, North Gondar Zone, Ethiopia by using Randomized Complete Block Design with three replications. The experiment was done in clay loam soils which having 0.101 total nitrogen and 5.73 available Phosphorus in ppm. The soil has a pH of 6.5, which is slightly acidic. The gross plot size was 6 m wide and 4 m long. Local sorghum variety and improved faba bean variety (Degaga) was used. Sole sorghum was planted at the spacing of 75 cm between rows and 15 cm between plants and sole faba bean planted at the spacing of 40 cm between rows and 5 cm between plants. 41/46 N-P2O5 was applied to sorghum both in the sole planting and intercrops. DAP at the rate of 100 kg ha-1 was applied to the sole faba bean and in the intercrop at planting.

Treatments

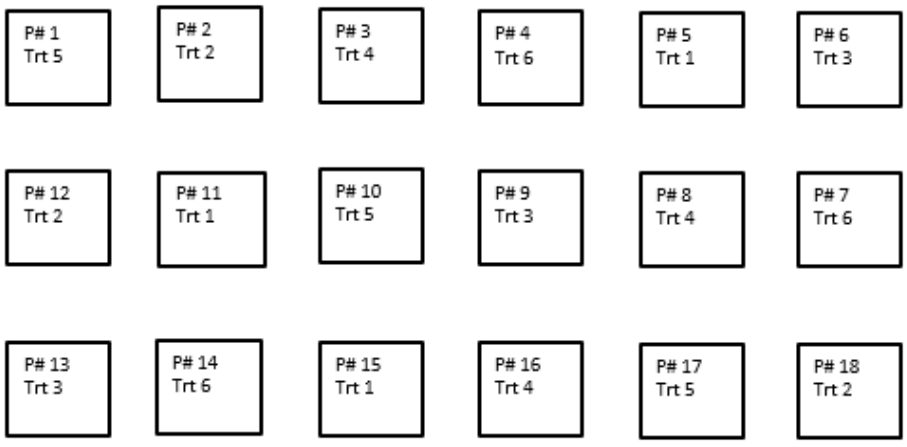
1. Sole sorghum
2. Sole faba bean
3. Sorghum/faba bean in 1:1 row ratio, faba bean planted simultaneously (sorghum planted in 75 cm X 15 cm distance between rows and plants, respectively).
4. Sorghum/faba bean in 1:1 row ratio, faba bean planted 10 days after sorghum planting (sorghum planted in 75 cm X 15 cm distance between rows and plants, respectively).
5. Sorghum/faba bean in 1:3 row ratio, faba bean planted simultaneously (sorghum planted in 150 cm X 15 cm spacing between rows and plants, respectively. Sorghum planted in two plants per hill. Faba bean planted 35 cm away from sorghum row and then at 40 cm spacing between faba bean rows).
6. Sorghum/faba bean in 1:3 row ratio, faba bean planted 10 days after sorghum planting (sorghum planted in 150 cm X 15 cm spacing between rows and plants, respectively. Sorghum planted in two plants per hill. Faba bean planted 35 cm away from sorghum row and then at 40 cm spacing between faba bean rows).

Land Equivalent Ratio (LER) values were calculated according to Willey (1979):

$$LER = \frac{P1}{M1} + \frac{P2}{M2}$$

Where, P1 and P2 are the yields of two different crops in intercropping and M1 and M2 are the yields of these crops in mono-cropping. LER > 1 shows intercropping advantage and LER < 1 means mono-cropping advantage.

Experimental layout



4 Results and discussion

Sorghum crop in the year 2013 showed that there was significance difference between treatments on stand count/4m row, biomass yield and grain yield. However, plant height had not significance difference. In this year the highest stand count/4m row was observed from Sorghum/faba bean planted in 1:3 row ratio, faba bean planted simultaneously and 10 days after sorghum. Hence, sole sorghum gave the highest grain and biomass yield when compared with other treatments.

Table 1: Effect of Sorghum/faba bean intercropping on plant height, stand count biomass yield and grain yield of sorghum 2013

Treatment	Plant height /Cm/	Stand count /4m row	Biomass yield /kg/ha/	Grain yield /kg/ha/	LER
T1	175.6	27[b]	13333[a]	3504[a]	1
T2					
T3	169.8	22[b]	7500[bc]	2385[b]	1.18
T4	172.2	25[b]	11000[ab]	3153[a]	1.35
T5	183.0	40[a]	6194[c]	1998[b]	1.27
T6	183.2	44[a]	7778[bc]	2257[b]	1.43
LSD	14.89	6.05	4007	701.26	

Maturity days, biomass yield, Grain yield and chocolate spot severity on faba bean crop in 2013 showed significance difference between treatments ($P<0.05$). However, plant height and 100 seed weight had no significance difference. The longest maturity days were recorded on treatments sorghum/faba bean 1:1 and 1:3 row ratio, faba bean planted simultaneously with sorghum, 107.7 and 102.7 days respectively. Sorghum/faba bean in 1:1 and 1:3 row ratio, faba bean planted 10 days after sorghum planting showed relatively tolerant for chocolate spot disease. Sole faba bean gave the highest grain yield (1831 kg/ha) followed by Sorghum/faba bean in 1:3 row ratio, faba bean planted 10 days after sorghum planting which gave 1441 kg/ha of grain yield (table 2).

Table 2: Effect of sorghum faba bean intercropping on the maturity days, plant height, chocolate spot disease severity, biomass yield, grain yield and 100 seed weight - 2013

Treatment	Maturity dates	Plant height	severity	Biomass yield kg/ ha	Grain yield kg/ha	100 seed wt
T1						
T2	96[b]	101.20	30[a]	9027[a]	1831[a]	56.47
T3	107.67[a]	109.93	26.67[a]	3944[bc]	923[c]	57.33
T4	96.67[b]	112.37	20[b]	3500[c]	830[c]	58.33
T5	102.67[a]	110.57	30[a]	5483[b]	1279[bc]	58.8
T6	95.67[b]	116.63	20[b]	4167[bc]	1441[ab]	57.03
LSD	5.04	34.4	4.8	1652.9	451	5.12

Table 3: Sorghum, Plant Height (cm), Stand Count/4m row, Biomass Yield (Kg/ha), LER in 2014

Treatment	Plant height	Stand count	Biomass Yield	Grain Yield kg/ha	LER
T1	175.9	15.8[ab]	11407	2537	1
T2					
T3	182.1	14.9[b]	9741	2404	1.69
T4	193.4	15.7[ab]	10259	2481	1.86
T5	172.3	22.3[a]	6833	1669	1.44
T6	187.7	20.2[ab]	8722	1889	2.08
LSD	25.6	6.96	5585	992	

In the year 2014, only one parameters, stand count/4 row, showed significance difference between treatments in sorghum crop at $P<0.05$. The other yield and yield component didn't show significant difference between treatments (Table 3). The highest number of stand count per 4-meter row obtained on fifth treatment number (T5), whereas, the lowest number was obtained on the treatment three (T3).

Table 4: Effect of sorghum faba bean intercropping on the maturity days, plant height, chocolate spot disease severity, biomass yield, grain yield and 10 seed weight in 2014

Treatment	Maturity dates	Plant height	severity	Biomass yield kg/ ha	Grain yield kg/ha	100 seed wt
T1						
T2	124[a]	90.9	30	4423	1207[b]	51.8
T3	120.3[ab]	90.9	30	3322	903[b]	48.8
T4	111.0[c]	99.6	23	4035	1066[b]	50.0
T5	123.3[a]	97.8	30	3530	947[b]	51.7
T6	113.0[bc]	94.2	30	4781	1615[a]	52.6
LSD	8	16	21	2268	308	12.8

Faba bean crop in 2014, maturity days and grain yield showed significance difference between treatments. Whereas, plant height, chocolate spot severity, biomass yield and 100 seed weight didn't show significance difference between treatments. Treatment number gave the highest faba bean grain yield, followed by sole faba bean planting.

The combined analysis of variance in sorghum crop showed that, the significance difference was obtained on parameters; stand count/4-meter row, biomass yield and grain yield. In the stand count/4m row, the highest number was recorded from treatment (T5), but the lowest number of stand count was recorded from treatment (T3, T4, and T5).

Table 5: Combined Sorghum Plant Height (cm), Stand Count/4m row, biomass Yield (Kg/ha), and LER in 2013 and 2014

Treatment	Plant height /cm/	Stand count/4m row	Biomass Yield /kg/ha/	Grain yield /kg/ha/	LER
T1	175.7	21.5[b]	12370[a]	3021[a]	1
T2					
T3	175.9	18.5[b]	8620[bc]	2395[bc]	1.39
T4	182.8	20.5[b]	10630[ab]	2817[ab]	1.56
T5	177.7	31.3[a]	6514[c]	1834[d]	1.33
T6	185.5	30[a]	8250[bc]	2073[cd]	1.69
LSD	12.7	4.6	3022	522.5	

The combined result in the year 2013 and 2014, maturity days, biomass yield and grain yield showed that there was significance difference between treatments, whereas, other parameters didn't show significance deference.

Table 6: Effect of sorghum faba bean intercropping on the maturity days, plant height, chocolate spot disease severity, biomass yield, grain yield and 100 seed weight of faba bean year in 2013 and 2014

Treatment	Maturity dates	Plant height	severity	Biomass yield kg/ ha	Grain yield kg/ha	100 seed wt
T1						
T2	110[a]	96.1	30	6725[a]	1519[a]	54.1
T3	114[a]	100.5	28	3633[b]	913[b]	53.1
T4	104[b]	105.9	22	3767[b]	948[b]	54.2
T5	113[a]	104.2	30	4507[b]	1113[b]	55.3
T6	104[b]	105.4	25	4474[b]	1528[a]	54.8
LSD	4.6	16.8	9.4	1256	241	6.7

5 Conclusions and recommendation

Sorghum plant height and faba bean chocolate spot disease were not showed significance difference in all treatments. According to the LER, T6 and T4 gave the highest value (1.65 and 1.56 respectively. Thus by considering the biomass yield of both crop and the LER, practicing of sorghum/faba bean in 1:3 and 1:1 row ratio when faba bean planted 10 days after sorghum planting gave the highest value.

***NOTE**: The data presented in this report are currently being elaborated for scientific publication, thus some of them are not final. The aim of this report is to summarize the nature and quality of the activities conducted and of the dataset generated, and to illustrate the main results obtained.*

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