Participatory variety selection of improved lentil varieties

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

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Synthesis

Activity type: Technology generation

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Summary report

The objective of this activity was to evaluate and identify adaptive, high-yielding and disease tolerant lentil varieties in Gumara Maksegnit watershed in Gondar Zuria district. Lentil (Lens culnaris Medik) in Ethiopia is amongst the principal cool season food legumes grown in Ethiopia mainly by subsistence farmers usually under rain-fed conditions. However, its production is constrained due to biotic and abiotic factors. There is a huge gap between potential yield and the actual yield farmers are getting for lentil in the zone. The gap between actual and potential yield is the result of mainly lack of adoption of improved production packages. Farmers are still using low yielding local varieties of lentil. In order to minimize this gap participatory variety selection with the objectives of selecting high yielding, disease tolerant and acceptable lentil varieties adapted to the growth environment was conducted in Gumara Maksegnit watershed. 10 released varieties each of were evaluated in RCBD with mother and baby trial in three sites in 2013 and 2014 main cropping season. In 2013 and 2014 combined ANOVA for yield and yield related traits revealed highly significant (P≤0.05) differences except days to maturity in 2014. The significant interaction of the varieties showed that the varieties respond differently across the sites. In this study farmers' selection and researchers were confirmed that Gudo, Teshale and Alemtena were found good for yield and other agronomic traits among the ten tested varieties. The highest yield was obtained on varieties R-186 and Gudo, which is 992.4 kg/ha and 893.9 kg/ha respectively. R-186 is the top yielding variety but it is late maturing and an obsolete variety and due to this reason, farmers must grow Gudo as the first choice and Teshale as secondary choice.

Schematic summary of information

Location:	Dinzaz and Dogola Kebeles, Gumara-Maksegnit watershed, Gondar
Easting:	03°47"48.6"
Northing:	13°73"71.5"
Elevation:	2025m a.s.l.
Period of implementation:	December, 2013 to December, 2014
Duration of trials:	Two years
Activity leader(s):	Getachew Tillahun tilahungech@yahoo.com
Other researchers:	Tewodros Tesfaye
Technical staff involved:	Tesfaay Jorgi

1 Background and rationale

Lentil (*Lens culnaris Medik*) in Ethiopia is amongst the principal cool season food legumes. The average annual harvests of lentil account 123718 hectare and its production within this year 1514999 quintal were produced (CSA2013). In Ethiopia, lentil grows between 1700-2400m a.s.l. with annual rainfall ranging from 700-2000 mm. The country has been top producer of lentil in African followed by Morocco and tenth in the world. Lentil is an invaluable source of protein (23-24%) for the vast majority of Ethiopian masses. The relatively high level of lysine in lentil compensates for low concentration in cereal grains hence when consumed in combination gives nutritionally well balanced diet (Muelbauer et al.1995). The straw/haul is an important source of feed for animals fattening. Besides, lentil is leading in fetching the local market price and comparably has significant export market option in field crops. Moreover, it offers an indispensable additional advantage emanating from its unique property in restoring and maintaining soil fertility through symbiotic biological nitrogen fixation. Lentil can fix up to 107 kg N/ha (Saxena, 1980) implying fixation of about 6,500-ton N annually in Ethiopia.

Consequently, Ethiopian lentil culture is characterized by growing the crop mainly in rotation with major cereals such as teff, wheat, barley and others. In such culture, a yield advantage of the succeeding cereal crop is realized as a result of the fixed nitrogen by the predecessor legume and also due to breakage of the life cycle of important diseases and insect pests.

National average production of lentil yields since 2000 have fluctuated between 509 (2002) and 876 (2008) kilograms per hectare. Productivity varies by region, however. The Ethiopian Export Promotion Agency reports that improved varieties yield 1,400– 5,000 kilograms per hectare on research fields and 900–3,000 kilograms per hectare on farmers' fields. In 2007, domestic lentil production supplied 111% of lentils consumed. On average from 1993 to 2007, Ethiopia produced 92% of local lentil supply. 2007 was the highest yielding year since 1993, the earliest data available, but still remained below world average yields. Ethiopian lentil yields are on equivalence with East African average yields and slightly greater than continent-wide averages for most years on record. Based on 2007 data, if Ethiopia were able to increase yields by six percent to meet world average yields, it could produce 117% of current supply levels.

Lentils consumption is an important part of the daily diet for most Ethiopians. Most lentils produces are consumed domestically. According to the Ministry of Agriculture and Rural Development, demand for lentils in both local and international markets has increased significantly in recent years.

Marketing of pulse crops are usually available at woreda (local), regional and terminal markets from wholesalers and retail shops as well as directly from producers at weekly markets in rural areas. Lentils command a high price and enjoy a strong demand in the national market, leading to their low export share compared to other pulses. The main destinations for exported lentils are Pakistan, Yemen and Djibouti.

The production constraints include both biotic (insects, diseases and weeds) and a biotic (temperature, soil fertility and drought) stress affecting the vertical or horizontal production of lentil and a lack of improved varieties that give high yield. According to the Food and Agriculture Organization and the World Food Programme, in 2009, there were only 809 quintals planted with improved lentil seed, compared to 123,215 quintals of improved wheat and 29,657 quintals of improved maize.

There are opportunities to expand the production of lentil in north Gondar because of accessibility of potential areas and improved varieties released by national and regional research centers, but which is not tested at Gondar Zuria condition yet.

2 Objective

The main objective of this research activity was to evaluate and identify adaptive, high-yielding and disease tolerant lentil varieties in Gumara Maksegnit watershed in Gondar Zuria district.

3 Experimental Methods

Ten improved Lentil varieties (Alemaya, Alemtena, Teshale, Derash, EL-142, R-186, Chalew, Chekole, Gudo, Adaa) including local check were evaluated for their adaptation and yield in 2014 across Gumara-Maksegnit watershed area in four farmer's site (mother baby trial), in Gondar Zuria. These varieties were improved released by Debre Zeit Agricultural Research Centre from national yield trial.

The experimental design was arranged in randomized complete block design with three replications (mother baby trial method). Each plot consisted of six rows spaced 20cm X 5m long. The plot area used was 6m2 (5m X 1.2m). A 1.5-meter distance was maintained between replication at all locations. Date of planting was the same for mother and baby trial. Planting was made at different Seed rate based on seed size. Blanket recommendation of DAP fertilizer was applied. Weeding and other agronomic practices were carried out as per recommendations of respective locations. Four middle rows were harvested, dried, threshed and cleaned for data collection.

Data on seed yield, agronomic and disease traits were taken from the central four middle rows of each plot. Days to flowering and maturity were separately taken when 50% and 90% crop stands flower and matured, respectively. The days were calculated beginning from the date of sowing. Plant height (cm) was taken at full maturity from five randomly selected plants of the central rows measured from the ground level to the top of the plant. Yield data was recorded from clean and dried samples. Plot yields were converted to kilogram per hectare. Thousand seed were counted and weighted. Percent moisture was determined from the mass of water lost by drying to the original milled sample and grain yield were adjusted for analysis by standard moister content.

4 Results

The mother trial Analysis of variance result showed that there were significant differences observed on all parameters at ($p \leq 0.5$). The mean for days to flowering of tested varieties ranged from 48 days (local) to 55 days (Gudo)(Table1). Days to maturity for tested variety ranged from 82 days (El-142, Teshale, Chekole) to 100 days (Adaa) showing highly significance difference among the tested varieties. Early maturing varieties complete their life cycle in relatively shorter period. Thus, early maturing varieties have advantage over the late maturity ones in environments where rain begins late and ends early. Plant height of the tested varieties ranged from the shortest 23.2cm (Chalew) to the tallest 33.5cm (Gudo). The highest yield was obtained on varieties Derso and Teshale, which is 1383.1 kg/ha and 1200 kg/ha respectively.

Table 1: Mother trial Mean performance of varieties for yield (kg/ha) and other agronomic characters in 2012/2013

Varieties	DF	DM	PPP	PHT	SPP	TSW	YLD
Alemaya	50cde	86cd	26.2cd	25.1ef	1.4c	24e	869.25c
Alemtena	49de	83cd	36.4abc	28.1bc	1.4c	33c	1194.7ab
Teshale	50cde	82cd	25cd	27.6bcd	1.6b	37b	1200.2ab
Derso	52bc	84cd	32.1bcd	31.9a	1.4c	27de	1383.1a
EL-142	52c	82cd	44.8ab	28.8b	1.8a	18.6f	1192.2ab
R-186	57a	95ab	26.6cd	28.5b	1.5bc	23.6e	814.2c
Chalew	51cd	98a	37.4abc	23.2f	1.4c	23.6e	892.6bc
Chekole	51cd	82d	37.4abc	25.8cde	1.8a	17.3f	835.8c
Gudo	55ab	98a	48.1a	33.5a	1.2d	28.6d	877.19
Adaa	53bc	100a	30.6cd	27.4b-e	1.5bc	46a	962.8bc
Local	48e	89bc	19.8d	25.7de	1.6b	19.6f	766.0c
Means	52	89	33.1	27.8	1.5	27.18	998.9
CV (%)	3.5	4.4	23.3	5.1	7.3	7.38	21.2
LSD (5%)	3.1	6.7	13.1	2.4	0.2	3.4	307.9

EL-142 and R-186 =out of production

Combined Analysis of variance result showed that there were significant differences observed on all parameters except pod per plant. The mean for days to flowering of tested varieties ranged from 48 days (local) to 55 days (Gudo) (Table 2). Days to maturity for tested variety ranged from 81 days (Alemtena) to 99 days (Adaa) showing highly significance difference among the tested varieties. Early maturing genotypes complete their life cycle in relatively shorter period. Thus, early maturing varieties have advantage over the late maturity ones in environments where rain begins late and ends early. Plant height of the tested varieties ranged from the shortest 23.6cm (Chalew) to the tallest 33.4cm (Gudo). The highest yield was obtained on varieties Alemtena, Derso and Teshale, which is 1197.92 kg/ha, 1135.66 and 1053.10 kg/ha respectively.

Table 2: Combined Mean performance of varieties for yield (kg/ha) and other agronomic characters in 2012/2013.

Variety	DF	DM	PPP	PTH	SPP	TSW	YLD
Alemaya	50ef	89b	35.68a-c(1.5)	25.64de	1.4cd	23.4^{e}	7650^{cd}(2.87)
Alemtena	50ef	81c	38.36a-c(1.5)	27.7cd	1.44cd	33.6^{b}	1198^{a}(3.089)
Teshale	50ef	85bc	30.2a-c(1.4)	27cd	1.48b-d	36b	1053^{a-c} (3.0)
Derash	54a-d	85bc	40.92ab(1.6)	32.2ab	1.3de	26.8cd	1136^{ab} (3.02)
EL-142	54abc	82c	40.4a-c(1.6)	28.04cd	1.64ab	18.2f	866^{a-d}(2.89)
R-186	54ab	95a	29.6a-c(1.4)	29.48bc	1.52bc	23.8e	733^{cd}(2.81)
Chalew	51d-f	98a	34.68a-c(1.5)	23.6e	1.4cd	24.2de	655^{d} (2.77)
Chekole	51c-f	83c	40.28a-c(1.5)	27.12cd	1.76a	17.6f	726^{cd} (2.85)
Gudo	55a	98a	42.64a(1.6)	33.4a	1.2e	28.8c	803^{b-d}(2.9)
Ada	52b-e	99a	28.2bc(1.4)	28.4cd	1.52bc	46.6a	789^{cd}(2.8)
Local	48e-c	85bc	26.56c(1.4)	28.24cd	1.56bc	18.8f	784^{cd} (2.89)
Means	51.8	89.15	35.2(1.53)	28.26	1.47	27.07	901.04(2.92)
CV (%)	4.7	5	9	8	10.6	8.5	4.5
LSD (5%)	3.1	5.7	14.4	2.9	0.19	2.95	338.96

(Note - *DF- days to flowering, DM- days to maturity, PPP - pod per plant, PHT- plant height, SPP-seed per pod, TSW- thousand seed weight*.)

In 2014/15 mother trial Analysis of variance result showed that there were significant differences observed on all parameters. The mean for days to flowering of tested varieties ranged from 42 days (local) to 77.3 days (R-186) (Table3). Days to maturity for tested variety ranged from 104 days (local) to 133 days (R-186) showing highly significance difference among the tested varieties. Early maturing varieties complete their life cycle in relatively shorter period. Thus, early maturing varieties have advantage over the late maturity ones in environments where rain begins late and ends early. Plant height of the

tested varieties ranged from the shortest 20.4cm (Alemaya) to the tallest 31.3cm (Gudo). The highest yield were recorded on varieties R-186 and Gudo, which is 967.1 kg/ha and 907.8 kg/ha respectively and the lowest yield were obtained on local variety. The highest and the lowest thousand seed weight were obtained on Gudo (36.4) and EL-142 (15.1).

Table 3: Mother trial Mean performance of varieties for yield (kg/ha) and other agronomic characters in 2014/2015

Varieties	DF	DM	PHT	PPP	SPP	TSW	YLD
Alemaya	45ef	112e	20.4f	23.1b	1.3bc	18.2de	523cd
Alemtena	49b-d	112e	24.1c-f	19.3bc	1.0c	31.2b	907ab
Adaa	48c-e	130b	27.9a-c	13.5d	1.7a	28.6b	672bc
Chalew	53b	127c	27b-e	32.3a	1.4ab	24c	749ab
Chekol	53b	110e	23.3ef	11.5d	1.5ab	16.1e	334d
Derso	51bc	112e	27.8a-c	20.4b	1.2bc	21cd	589bc
Gudo	47de	125d	31.3a	14.3cd	1.2bc	36.4a	908ab
El-142	52b	108h	22.3f	19.1bc	1.5ab	15e	363d
R-186	70a	133a	29.3ab	35.9a	1.5ab	22.4c	967a
Teshal	45ef	111f	23.7d-f	19.5bc	1.3bc	32.5ab	903ab
Local	42f	104i	27.7a-d	5.8e	1.0c	9f	108
Means	50.5	116.8	25.9	19.5	1.32	25.4	638.4
Cv%	4.9	0.5	9.3	17.1	17.7	10.1	20.5
LSD(5%)	**	**	**	**	**	**	**

EL-142 and R-186 =out of production

Table 4: Combined Mean performance of varieties for yield (kg/ha) and other agronomic characters in 2014/2015.

Variety	DF	DM	PHT	PPP	SPP	TSW	YLD
Alemaya	46c	107	19.8d	18.6b	1.3bc	21.2bc	425de
Alemtena	49bc	116	23.3cd	17.1bc	1.2cd	30.4ab	783a-c
Adaa	51bc	122	27.1ab	15.6bc	1.6a	28.3b	626cd
Chalew	54b	119	24.6bc	26.4a	1.4a-c	22.3bc	723bc
Chekol	54b	105	21.8cd	11.8c	1.4a-c	15cd	332ef
Derso	51bc	106	27.4ab	20.3b	1.2b-d	20.5bc	586cd
Gudo	49bc	118	29.4a	15.8bc	1.2cd	34.6a	894ab
El-142	51bc	104	21.9cd	17.6b	1.3a-d	17.3cd	358e
R-186	64a	126	28.8a	31.1a	1.5a	21.9bc	992a
Teshal	46c	106	21.3cd	17.5b	1.4a-c	31ab	782a-c
Local	47c	108	26.9ab	7.8d	1.04d	23.5b	126f
Means	51	112	24.76	18.14	1.31	24.27	602.34
Cv %	12.2	8.59	11.35	23.25	18.83	17.72	28.54
LSD	**	ns	**	**	*	**	**

**, Significance at p≤0.01, * - significance at p≤ 0.05 level, and; ns-non significant

(Note - *DF- days to flowering, DM- days to maturity, PPP - pod per plant, PHT- plant height, SPP- seed per pod, TSW- thousand seed weight*.)

Combined Analysis of variance result showed that there were significant differences observed on all parameters except days to maturity. The mean performance of days to flowering varied from 46.2 to 64.2 days for variety Alemaya and R-186 respectively. Plant height of the tested varieties ranged from the shortest 19.8cm (Alemaya) to the tallest 28.8cm (R-186). The largest and the smallest 1000 seed weight were recorded on Gudo and Chekol which is 34.5 g and 15.02g respectively. The highest yield was obtained on varieties R-186 and Gudo, which is 992.4 kg/ha and 893.9 kg/ha respectively (Table 4).

Participatory Evaluation of lentil Varieties

Participatory evaluation of lentil varieties was done at two stages by 20 farmers (3 women and 17 men). Firstly, discussion was made with farmers on plant characters used by farmers for lentil variety selection, and agreed that earliness, height-branching, pod setting, seed size, disease tolerance, crop stand and seed yield are important parameters for lentil variety selection at Gumara Maksegnit watershed. The first evaluation was carried out at the field for plant characters such as earliness, plant height-branching and pod setting and etc. while the second evaluation was for seed size and seed yield at harvesting time by farmers and after harvesting by researchers. Unless the variety meets the requirements of farmers and consumers, it is less likely to be widely adopted and, therefore, the demand for seed can be addressed. In this study farmers' selection were confirmed that Gudo, Teshale, Alemtena and Derso were found good for yield and other agronomic traits among the ten tested varieties based on farmer's selection criteria (Table 4). Farmers' evaluation and selection almost match 90% with the researchers' evaluation and selection (Table 3). It has to be noted that for both study years, the average yield in the study area is lower than the yield at national level.

Table 5: Participatory variety evaluation result at Gumara Maksegnit

Variety	Farmers' evaluation criteria's	Rank
Gudo	Number of pods/plant, tolerant to disease, vigorous growth good population, good branching and large seed size.	First
Teshale	Number of pod/plant, tolerant to disease, good branching, early maturing period	Second
Alemtena	poor stand, good branching habit	Third
Derso	Early maturing, good branching	Fourth

***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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