The Effect of Ridging and Tie-Ridging time on the yield performance of sorghum

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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About the Project

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Cover photo: Ridging and Tied ridging experiment field performance during vegetative stage | 27 Aug. 2015 | Picture by Muuz Gebretsadik

About ICARDA

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Synthesis

Activity type: Technology generation

Report submitted by: Ertiban Wondifraw

Summary Report

The effect of timing of tie-ridging on the yield and yield components of sorghum was studied at Gumara-Maksegnit watershed, Gondar Zuria woreda, Amhara Region, Ethiopia, with budget with a budget support of ICARDA. In the study area the amount of annual rainfall ranges from 995 to 1175 mm, with more than 70% of the rain concentrated within three months. Hence, there is the threat of unbalanced soil moisture throughout the year, demanding urgent attention. In the watershed, most of the rain falls in the short period between June and August, triggering water logging on the Vertisols which causes crops to be flooded. On the other hand, the amount of rain decreases drastically after August, resulting in water shortage. This also causes major crop yield losses, evidencing the importance to manage the soil moisture during these two contrasting seasons. Tie-riding is a common practice to balance soil moisture by releasing water from the plots when it is excess and by harvesting water into the plots for extended plant use.

In the framework of the research project 'Reducing Land Degradation and Farmers' Vulnerability to Climate Change in the Highland Dry Areas of North-Western Ethiopia', experiments were done to evaluate the optimal timing of tie-ridging for sorghum yield. A field trial was implemented during 2014 and 2015 seasons on farmers' plots where the soil class is dominantly Vertisols. These farmers were encouraged to engage in this experiment by organizing field days at different stages of the plant growth; they gave their views on the importance moisture management for their sorghum field and promised to act accordingly. The experiment was laid out in a randomised complete block design (RCBD) with 3 replications, investigating 8 different timings of tie-ridging treatments. All the necessary management practices and inputs (87kg N and 46 kg P2O5 per hectare) were supplied equally for each plot. Data was analysed for variance and LSD at 5% level of significance. The result revealed that the timing of tie-ridging has a significant effect on grain and stover yield of sorghum. The maximum yield was recorded at planting at flat land, ridged three weeks after planting and tied 6 weeks after planting.

Schematic summary of information

Location:	Abakaliyo Village, Gumara- Maksegnit watershed, Gondar
Easting:	0345829
Northing:	1373479
Elevation:	1994m a.s.l.
Period of implementation:	June, 2014 to December 2015
Duration of trials:	2 years;2 seasons)
Activity leader(s):	Ertiban W. (ertiban@yahoo.com), Muuz Gebretsadik and Sisay Ambachew,
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1 Background and rationale

Sorghum (*sorghum b.*) is the fourth most important world cereal after wheat, rice and maize. It is a staple food in the drier parts of tropical Africa, India and China (Pursgrove, 1995). Sorghum is also a major and one of the leading traditional food crops in Ethiopia with approximately 297,000 ha production area coverage per annum (Wortmann et al., 2006), which comprises 15-20% of the total cereal production in the country. Climate change is a threat to crop productivity in most vulnerable region of the world, particularly the semi-arid regions where higher temperature and increase in rainfall variability could have substantially negative impact (Abdulai A. et al., 2012). The 21 century surface air temperature projection showed that there is a rise of 1.8 - 4.0 °C with a very likely occurrence of unpredictable extreme events such as drought and flood (IPCC, 2007). In addition to the likely occurrence of climate variability in the study area, the nature of rainfall in the area is erratic type. Almost 70% of the total annual rainfall occurs only in two to three months (from June to August) and the rest two to three months (September to November) of the growing season faces terminal moisture stress (dry spells). This is prospective to affect production of many crops including sorghum. The consumptive water use (ET) of 110 to 130 day growing period sorghum crops range between 450 and 750 mm, depending on evaporative demand. Water stress during panicle initiation would reduce panicle size and potential grain number; severe stress at flowering would inhibit pollination; and stress at early grain filling would cause abortion of youngest developing grains and reduce weight per grain. Grain size is also reduced if stress occurs late during grain filling. Therefore, one of the coping up mechanism of the mentioned problems is farm water management which includes tie-ridging.

A research revealed that the most important constraint of sorghum production in east Africa is water stress. Particularly in Ethiopia soil water deficits during crop establishment and during grain fill were recognized as major constraints (Wortman et al, 2009;

Tesfahunegn et al, 2009.). On the other hand, in many parts of Ethiopia including the study site, the nature of rainfall is erratic which results, water logging at the crop development stage especially for Vertisols. All these need appropriate water management techniques.

In-situ water harvesting technique like tie-ridging is one of the practices in sorghum production areas of dry lands to improve sorghum production. A research revealed that tie-ridging increases sorghum yield up to 46% as compared to the farmers practice in the dry areas of Ethiopia (Abebe et al, 2009). Taye et al (2013) also reported that tie-ridging is one of the practices to control weeds like Straga through improving moisture content of the soil. Another research in the dry lands of Ethiopia also found that, tie-ridging that was done before planting improves soil water availability and increases sorghum yield over flat land planting and the farmers 'shilshalo' practices (Tesfahunegn et al, 2009). Gerbu (2015) also reported that yield advantage of 56% to 68% with cultivation of improved sorghum varieties with fertilizer and tie-ridging over local practices (local cultivar without fertilizer sown in flat planting.

Tie-ridging is developing ridges with 20-30 cm depth and commonly spaced 75 cm apart, either before, during or after planting. Crops like sorghum and maize may sow on the ridge or furrows. The furrows can be tied at intervals of 2 or more meters, depending on field conditions, to prevent runoff in the furrows. The effect of tie-ridging on soil water content and crop yield differs from season to season and from location to location (Gebreyesus et al, ND). This is due to tie ridging effect on the crop is depending on climatic data, soil characteristics, slope, and crop.

2 Objective

The main objective of this research activity was to evaluate the timing of ridging and tie-ridging on the productivity of sorghum.

3 Experimental Methods

The study was carried out in Gumara-Maksegnit watershed in North Gondar administrative zone in the Amhara National Regional State, Ethiopia. The watershed is located between 120 23' 53" to 120 30' 49" latitude and 370 33' 39" to 370 37' 14" longitude and an altitude. The long term average annual rainfall is about 1052 mm which is similar to the first experimental year annual rainfall amount, but the amount of rainfall in the second season was only about 600mm. The mean minimum and maximum temperatures of the area are 13.3 °C and 28.5 °C (NMSA, 2009). The soil of the site is Vertisols and the texture is clay.

An on-farm experiment was conducted on sorghum on a Vertisols in 2014 and 2015 cropping season. Local Sorghum variety was used and sown at the onset of rains (usually the second week of June). Recommended amount of 46 kg ha-1 P2O5 and 87 kg ha-1 N fertilizers were applied equally for each treatment. DAP and Urea fertilizers were used as fertilizer source to supply phosphorous (P) and nitrogen fertilizers respectively. Gross plot size was 5 m x 4.5 m (22.5 m2). Sorghum seeds were sown in rows at spacing of 75 cm between rows and 20 cm between plants and were thinly covered with soil. Plots were kept weed free by hand weeding and all other agronomic practices were applied to each plot equally. Tie-ridging was developed ridges with 20cm depth and 75 cm apart and tied at intervals of 2 m during and after planting based on the time fix for each treatment. Composite soil samples were collected before planting. Soil chemical analysis was done at Gondar Soil Laboratory and the following result was recorded.

Table 1: soil physical and chemical results of the surface layer (0-25cm)

Soil depth (cm)	Soil Structure Shape, size and grade	OM Walkley & Black (%)	Bulk Density/c (m^3)	pH H_2O 1/2.5	T.N Kjeldhal (%)	Exch.P Olsen (ppm)	Sand (%)	Silt (%)	Clay (%)	Text class
>100	Blocky, coarse, strong	1.54	1.63	7.05	0.10	31.38	30.56	11.68	57.76	Clay

There were eight treatments which are:

1. Tie-ridging at planting: the plots were tied and ridged at the time of planting.
2. Ridging at planting and tied at the time of Full stand: the plots were ridged at the time of planting and tied at the time of full stand establishment which were almost 7 weeks after planting
3. Flat at the time of planting, tie-ridging three weeks after planting: on this case planting was done on flat plots and it was tie-ridged after three weeks of planting
4. Flat at the time of planting, ridging three weeks after planting and tied six weeks after planting: planting was done at flat land and it was ridged after 3 weeks, then it was tied 6 weeks after planting
5. Flat land at the time of planting, ridging three weeks after planting and tied nine weeks after planting: it was flat up to three weeks, and ridged after three weeks and tied nine weeks
6. Flat land at the time of planting, ridging three weeks after planting and tied twelve weeks after planting: similarly planting was done at flat land and ridging was done three weeks after planting then it was tied twelve weeks after planting
7. Flat at the time of planting, tie and ridging eight weeks after planting
8. Control, flat throughout: no tie-ridging throughout the growing season.

In the watershed farmers usually plant sorghum at flat land in broad cast. Fertilizers application and other agronomic practices like weeding, row planting and tie-ridging are not common. Farmers have their common practice for sorghum planting which is called 'shilshalo' which is a practice that farmers plow their sorghum plot after well establishment of the plant using oxen for the purpose of tinning and reducing weeds. Some-times they do also remove large weeds after 3 to 4 months of planting using sickle and they use the removed weeds for animal feed.

All the treatments were received equal amounts of N and P_2O_5 fertilizer: Planting was done in 75cm and 20cm between rows and plants spacing respectively. The seeds were drilled in rows then tinning and transplanting were done at establishment. Weeding was done four times throughout the growing season.

4 Statistical aspects

- Treatments: the study had eight treatments with a single factor of time of tie-ridging.
- Null hypothesis: time of tie-ridging don't affect yield and yield components of sorghum.
- Statistical design: the design was randomized complete block design with three replications.

The response variables measured were: plant height in cm, head weight in g, Stover yield in tone, head length in cm and yield in tone, each variables were taken from the middle four rows (3m5m plot size), 2 rows were left to avoid border effects. Soil moisture was also monitored in the growing season at different levels of moisture regime (from 0-20, 20-40, 40-60, 60-80 cm depth)

Statistical analysis: Analysis of variance was carried out with 1 factor (time of tie-ridging). Means and standard errors were calculated for the time of tie-ridging. Software: SAS version 9 statistical software was used for analysis

5 Results

The 1st year result showed that a significant highest grain and Stover yield were obtained at which sorghum was planted at flat land, ridging after three weeks and tied 6 weeks after planting. While the least yield was obtained at tie-ridging and ridging was done at the time of planting. The 2nd year result showed that flat planting and tie-ridging three weeks after, flat planting, ridging three weeks after planting and tied six weeks after planting and flat land planting gave a highest significant yield while similar to in the 1st year, riding and tie riding at planting gave the least yield. This result is linked to the crop water requirement and the amount of precipitation during the growing season. In the

second year flat land throughout the growing treatment gave a maximum yield this could be due to the amount of precipitation in the second year is reduced from 1015mm in the 1st year to 600mm in the 2nd year due to climate variability in this particular year.

Figure 1: Ridging and Tied ridging experiment field performance during vegetative stage. Detail of longitudinal ridges and transversal ties.

August 2015 | Photo by Claudio Zucca

Table 2: effect of timing of tie-ridging on sorghum grain and stover yields

Treatments	St Yield ton/ha	Yield ton/ha
Tie Ridging at planting	12.16[b]	3.77[bc]
Ridging at planting and tied at full stand	10.99[b]	3.40[c]
FL at planting, TR 3 weeks after planting	14.26[ab]	4.39[ab]
FL at planting, R 3 weeks after planting and tied 6 weeks after planting	15.78[a]	4.487[a]
FL at planting, R 3 weeks after planting and tied 9 weeks after planting	13.61[ab]	4.40[ab]
FL at planting, R 3 weeks after planting and tied 12 weeks after planting	13.12[ab]	3.95[abc]
FL at planting, tie and R 8 weeks after planting	12.50[ab]	4.14[ab]
Control, flat throughout	13.09[ab]	3.93[abc]
CV (%)	14.44	9.88
LSD (0.05)	3.3	0.7

FL = Flat level, TR= tie-ridging, R= ridging

Table 3: Effect of time on tie-ridging on sorghum grain and stover yields (year 2 - 2015)

Treatments	St Yield t/ha	Yield ton/ha
Tie Ridging at planting	11.14	4.25[b]
Ridging at planting and tied at full stand	11.77	4.46[b]
FL at planting, TR 3 weeks after planting	13.50	4.65[ab]
FL at planting, R 3 weeks after planting and tied 6 weeks after planting	12.47	4.93[ab]
FL at planting, R 3 weeks after planting and tied 9 weeks after planting	12.91	4.43[b]
FL at planting, R 3 weeks after planting and tied 12 weeks after planting	13.91	4.51[b]
FL at planting, tie and R 8 weeks after planting	13.48	5.12[ab]
Control, flat throughout	14.20	5.65[a]
CV (%)	20	13
LSD (0.05)	ns	1.09

FL = Flat level, TR= tie-ridging, R= ridging

6 Special issues raised

The climatic situation in the second experimental period was unexpected which has a probability of 10 years return, the amount of rainfall was reduced from 1000 mm annual average to 600mm. Further research is important to catch the climatic variability (rain fall nature) of the area.

***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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