OPEN ACCESS Freely available online

Global Journal of Biology, Agriculture & Health Sciences

Research Article

Short Term Effect of Conservation Agriculture for Sustainable Wheat Production in South East Arsi, Ethiopia

Almaz Admasu*, Dawit Habte, Debele Debela, Tolessa Debele

Kulumsa Agricultural Research Center, GIZ–ATC Kulumsa Agricultural Research Center, SARD-SC Wheat Project, Ethiopia

ABSTRACT

Conservation Agriculture (CA) can be a possible technique to mitigate reduction in soil quality, reduce runoff and soil erosion, and increase in situ soil moisture conservation, thereby improve crop yield. The objective of this study was to test and validate beneficial CA practices for sustainable wheat production and enhance small-scale farmers know how and skill for adoption. Three CA technology verification trials were conducted during 2013-2016. The first trial compared CA with conventional agriculture (CVA) on-farmers fields in Sinana IP sites during 'meher' or big rainy season in 2013-2016. In CA verification, soil disturbance was restricted to the absolute minimum; viz. the soil was disturbed only to place the seed in the soil at the time of sowing. In contrast, in CVA the soil was plowed four times with the local oxen-plow 'maresha' prior to sowing to obtain a suitable seedbed. Weed control in the CA was done by applying round-up at the rate of 3 L/ha prior to planting while Pallas 45OD at 0.5 L/ha and 2,4-D at 1 L/ha were used as post-emergence application. The recommended weed control practice was used for conventional agriculture viz. twice hand weeding at tillering and booting stages. During 'belg' (small rainy season faba bean was used as cover or break crop in early 2014 and 2015. The second CA verification trial was initiated with the introduction of zero tillage planter at Kulumsa Research Center involving zero tillage CA, minimum or reduced tillage CA and CVA in 2016. The third trial was conducted in low rainfall areas in which CA, CA coupled with tie ridge and CVA were compared at Dhera in 2014. Results of the first trial indicated that at the initial year CVA gave more wheat yield than CA. The benefits of CA has increased progressively over years and on average CA yielded 12.5% more wheat yield than CVA. Similarly, zero tillage CA increased wheat grain yield by 7.1% and 11.6% as compared with conventional and reduced tillage, respectively. In arid and semi-arid areas, CA coupled with tie-ridge significantly increased wheat grain yield as compared to conventional agriculture. Thus, CA could be more applicable to moisture stress /erratic rainfall areas as compared to high rainfall areas and wheat farmers in drought prone regions could possibly adopt CA technology.

Keywords: Conservation agriculture; Herbicide; Bread wheat; Grain yield.

INTRODUCTION

Conservation Agriculture (CA) can be a possible technique to mitigate reduction in soil quality, reduce runoff and soil erosion, and increase in situ soil moisture conservation, thereby improve crop yield Hobbs et al. [1] and Gowing and Palmer, et al. [2]. Conservation agriculture (CA), a combination of ancient and modern agricultural practices, has three basic principles viz. zero/minimum disturbance of the soil, good soil cover with residues and crop rotation. Zero/minimum tillage usually coincides with the retention of crop resides on the soil surface [3]. Wheat straw is often regarded as a low quality resource in the regions in spite of its abundance and can play a major role in improving wheat production sustainably.

CA practices have been successfully adopted on intensive, large-scale farms in many dry land regions, where they have become an essential component of sustainable cereal-based farming [4,5]. Reported disadvantages include the prevalence of certain weeds, pests and diseases that are difficult to control without tillage, and the high conversion costs for equipment. It has been also proposed that CA is suitable to address agricultural problems in smallholder farming systems of eastern Africa, where productivity is chronically low and mostly declining [6].

Correspondence to: Almaz Admasu, Kulumsa Agricultural Research Center, GIZ–ATC Kulumsa Agricultural Research Center, SARD-SC Wheat Project, Ethiopia, Email: admasualmaz@yahoo.com

Received: February 03, 2021, **Accepted:** February 18, 2021, **Published:** February 25, 2021

Citation: Admasu A, Habte D, Debela D, Debele T (2021) Effect of Conservation Agriculture for Sustainable Wheat Production in South East Arsi, Ethiopia. Glob J Agric Health Sci. 10: 104

Whether or not CA provides benefits for smallholder systems in Africa has been subject to an ongoing debate [7]. A major criticism is that the socio-economic dimensions of smallholder farms are often insufficiently addressed in existing CA research. For example, poor farmers lack the resources to purchase expensive inputs, which may or may not be available locally. Greater reliance on hand weeding is likely to increase the workload of women and children.

In addition, residue retention usually conflicts in farming systems with livestock, where crop residues are a valued feed, other uses includes its use as fuel, and in construction. In Ethiopia, on-farm and researcher-managed CA experiments have been conducted across a range of dry land agro-ecosystems since 2001. Thus, this activity was conducted with the objective of this study was to test and validate beneficial CA practices for sustainable wheat production and enhance small-scale farmers know how and skill for adoption [8].

MATERIALS AND METHODS

Description of the Study Site

Three CA technology verification trials were conducted during 2013-2016. The first trial compared CA with conventional agriculture (CVA) on-farmers fields in Sinana IP sites during 'meher' or big rainy season in 2013-2015. The third trial was conducted in low rainfall areas at Dhera during 2014. The second trial was initiated with the introduction of zero tillage planter at Kulumsa Research Center during 2015-2016.

Kulumsa Agricultural Research Center (KARC), which is located in Tiyo Woreda of Arsi Zone in the Oromia National Regional State, Ethiopia. It is situated 160 km southeast of Addis Ababa and 8 km North of Asella town at an altitude of 2200 meters above sea level (masl) and 8° 01'10" N latitude and 39° 09' 11"E longitude and at an altitude of 2250 m.a.s.l. The long term average annual rainfall is 840 mm, with most of the rain falling between June and September. The average monthly max and minimum temperatures lie from 22.7 to 24.9°C and 8.5 to 11.9 °C for the months of Jan - June and from 20.8 to 22.6°C and 8.2-11°C for the months of July – December, respectively. The dominant soil is Haplic Luvisols; and the agroecology is Tepid to cool moist mid highlands (Ethio-Italian Development Cooperation, 2002).

Dhera is part of the central rift valley and is found around Awash river. It is usually hot but the annual rainfall is sufficient to grow lowland wheat, but the rainfall distributions may vary to affect crop yields. Based on 16 years rainfall data the minimum annual rainfall recorded is 370mm and the maximum 839mm. The annual rainfalls in most years lie between 500mm and 800mm. The monthly average maximum and minimum temperature vary from 20-25 and 5-10°C, respectively. The Soils of the area is Lithic Leptosols (Ethiop-Italian Arsi-Bale Development project, 2002).

Experimental Treatments, Design and Procedures

The first trial compared Conservation Agriculture (CA) with conventional agriculture (CVA) on-farmers fields in Sinana IP sites during 'meher' or big rainy season in 2013-2016. The second CA verification trial was initiated with the introduction of zero tillage planter at Kulumsa Research Center involving zero tillage CA, minimum or reduced tillage CA and CVA in 2016. The third trial was conducted in low rainfall areas in which CA, CA coupled with tie ridge and CVA were compared at Dhera in 2014.

The treatments were laidout in randomized complete block design (RCBD). In CA verification, soil disturbance was restricted to the absolute minimum; viz. the soil was disturbed only to place the seed in the soil at the time of sowing. In contrast, in CVA the soil was plowed four times with the local oxen-plow 'maresha' prior to sowing to obtain a suitable seedbed. Weed control in the CA was done by applying round-up at the rate of 3 L/ha prior to planting while Pallas 45OD at 0.5 L/ha and 2,4-D at 1 L/ha were used as post-emergence application. The recommended weed control practice was used for conventional agriculture viz. twice hand weeding at tillering and booting stages. During 'belg' (small rainy season faba bean was used as cover or break crop in early 2014 and 2015.

Data Collection

Agronomic data on grain yield and yield components such as spike length, number of seed per spike, plant height, number of spikes per m2 (SPM), grain and biomass yields were collected at the recommended time. Information on disease and pest incidences and lodging was also collected. Harvesting was done by machines. Hundred culm weight (100c) were collected from four to five points within a plot and slashed from close to the ground surface and the dry matter yield of above-ground biomass was determined. Grain yield was determined from total areas of the plots by used combiner to harvested samples. Yield adjustments were made based on 12.5% moisture content. For data analysis SAS 9.0 was used.

RESULTS AND DISCUSSION

Results of this experiment was shown statistically non-significant in all location ANOVA table. However, Results of the first trial indicated that at the initial year CVA gave more wheat yield than CA. The benefits of CA has increased progressively over years and on average CA yielded 12.5% more wheat yield than CVA.

Similarly, zero tillage CA increased wheat grain yield by 7.1% and 11.6% as compared with conventional and reduced tillage, respectively. On Kulumsa the highest grain yield 4377 and 5750 kg/ha were obtained during both 2015 and 2016 years respectively under Zero conservation tillage whereas the second highest was 4087 kg/ha obtained from conventional tillage method during 2015 whereas during 2016 reduced tillage was obtained better yield than conventional tillage practice. The last yield was obtained from reduced tillage it is about 3922 kg/ha during 2015 but it was obtained better yield during 2016. Comparing the effect of different tillage methods on grain yields, even if, the average yields were obtained from conservation Agriculture is better than others.

CONCLUSION

In general, CA increased wheat yield by 11.5% as compared to conventional agriculture. Moreover, CA has been found more applicable to moisture stress or erratic rainfall areas where wheat crop is predisposed to intermittent dry spell as compared to high rainfall areas. Wheat farmers in drought prone areas could possibly adopt CA technology.

In Ethiopia, a country where natural resources degradation is a very serious - and worsening -problem for livelihoods, promoting soil conservation techniques such as conservation agriculture is an important intervention towards achieving food security through sustainable farming.

Conservation Agriculture is based upon Agro-ecological zones,

soil life and health; therefore soils have to be brought up to a condition where healthy life can develop. Physical and chemical soil limitations like compactions; pH have to be corrected before changing to Conservation Agriculture. Especially in highly degraded or depleted soils, this means some investment is necessary to recover them, such as removing compactions, liming, use of green manure and synthetic fertilizer to control extreme nutrient deficiencies. It is a different production system and one of the biggest changes is in weed control. In conventional tillage, generally no special knowledge is needed about specific weeds because tillage implements bury and kill most of the weeds. In Conservation Agriculture often farmers must know the weeds and herbicides as well as other characteristics to control specific weed and avoid competition with crops.

Most advantages of Conservation Agriculture in terms of building up of soil life, soil organic matter and weed management come from permanent cover of the soil. Not tilling the soil however provides the basis for the soil cover to be maintained, the soil organic matter not to be mineralized faster than it can be supplied and for the soil life, macro-pores and structure not to be disturbed, which reduces enormously erosion control and flood prevention under CA. No-tillage with low amount of crop residues does not give the full benefits of the system and often results in yield decrease in the first two to three years.

REFERENCES

1. Hobbs PR, Sayre K, Gupta R. The role of conservation agriculture in sustainable agriculture. Philos Trans Roy Soc B. 2008;363:543-555.
2. Gowing JW, Palmer M. Sustainable agricultural development in sub-Saharan Africa: the case for a paradigm shift in land husbandry." Soil Use Manag 2008;24(1): 92-99.
3. Pretty J. Agricultural sustainability: concepts, principles and evidence. Philosophical Transactions of the Royal Society of London B. 2008;363(1491):447–466.
4. Thomas GA, Titmarsh GW, Freebairn DM, Radford BJ. No-tillage and conservation farming practices in grain growing areas of Queensland - a review of 40 years of development. Aus J Exp Agri 2007;47: 887-898.
5. Lyon D, Bruce S, Vyn T, Peterson G. Achievements and future challenges in conservation tillage 2004.
6. FAO 2010 Conservation agriculture 2010.
7. Giller KE, Witter E, Corbeels M and Tittonell P. Conservation agriculture and smallholder farming in Africa: The heretics' view. Field Crops Res 2009;114:23-34.
8. FAO. Mitigating climate change: Conservation Agriculture stores soil carbon. Recommendations of the Conservation Agriculture Carbon Offset Consultation 2008.