

Farmers' Perception on Glyphosate Application in Conservation Agriculture System of Northern Ethiopia

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Abstract

This study was conducted to assess the farmers' perception on application of glyphosate in CA-based systems in Hintalo Wejerat and Dogua Temben districts, Tigray, northern Ethiopia in 2013 growing season. Two tillage practices (DER+, CT) were assessed in the study sites (Hagereselam and Adigudom). The CA based system derdero+ (DER+) is based on traditional tillage system of bed and furrow using Mahresha with a 30% crop residue. Conventional tillage (CT) is a repeated tillage by the availability of oxen using Mahresha the same to local tillage system. Farmers' perception about CA-based systems was assessed based on the selected target group. Cost benefit ratio was determined to compare the CA and CT systems. From the selected target group 68.8% of them are still continued CA tillage system with glyphosate application. Farmers who practiced CA-based systems (64%) have appreciated the use of glyphosate to grass and other perennial weed control. Similarly, a Chi-square (χ^2) test showed that there was a significant difference ($P= 0.001$) on the perception of farmers. Higher net benefit (\$1136 ha⁻¹) were gained from the DER+ compared to traditional planting system (\$362 ha⁻¹).

Keywords: Farmers' perception, Glyphosate, weed control

1. Introduction

Ethiopia is rainfall dependent and characterized by erratic rainfall and climate instability. Adverse land degradation like soil erosion, influence in soil biological activities and diversities, plant nutrient and organic matter depletion are the main challenges for agricultural productivity and sustainability (Grepperud, 1996; Pender and Gebremedhin 2006). Those problems are resulted due to the long term human exploitation of natural resources, degradation of cropland due to repeated tillage, complete removal of crop residues at harvest (Tesfay *et al.*, 2011 and Lankriet *et al.*, 2012). Conservation Agriculture (CA) has been promoted as one of the possible solutions to natural resource conservation, improve in-situ moisture conservation and increase crop yield in northern highlands of Ethiopia (Tewodros *et al.*, 2009; Tigist *et al.*, 2010; Nyssen *et al.*, 2010; Tesfay *et al.*, 2011; Tesfay *et al.*, 2012). Regarding to reduction of tillage frequency in CA, weed infestation is a major problem for crop yield loss (Blackshaw *et al.*, 2001) and is a major challenge for the wider adoption of CA. Use of glyphosate on farmers' field for a long period of time in Dogua-Tembien and Hintalo Wajirat districts was used to assess the farmers' perception on effect of glyphosate to weed control and to consider the economic effect in CA. The hypothesis was that using glyphosate in CA-based practices of *derdero+* to control weed before the crop emerged accepted by the local farmers in CA-based systems.

2. Materials and Methods

2.1 The study area

The study site was under rainfed conditions in Hagereselam (13⁰39'N, 39⁰10'E) at an altitude of 2550 m.a.s.l. and in Adigudem (13⁰14'N, 39⁰32'E) at an altitude of 2100 m.a.s.l. in Tigray, northern Ethiopia. Adigudom is located in Hintalo Wejerat district, South Eastern Zone of Tigray Regional State. Hagereselam is located in South Eastern Zone of Tigray in Dogua Tembien district.

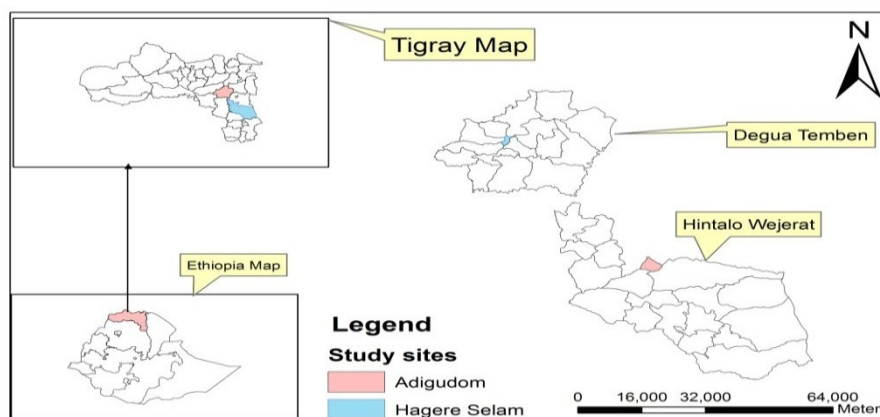


Fig.1 Location map of the study area

2.2 Tillage and cropping practices

Three to four tillage operations are conventionally done with an oxen-drawn *Mahresha* to control weeds, improve infiltration and prepare a fine seedbed, particularly for teff (Tesfay *et al.*, 2012b). The temporal pattern of plowing depends on the availability of oxen, type of crop and rainfall. The CA system used was *derdero+* (*DER+*) which is locally practicing by the farmers in the form of bed and furrow system to retain water slowly and drained excess water at high rain fall areas and time (Nyssen *et al.*, 2010). Since 2007 MU-IUC program, which introduce *DER+* to the study sites through modifying the local system with addition of crop residue management and by making the beds to be permanent with only refreshing the beds at the period of sowing. Besides non-selective herbicide glyphosate (N-(phosphonomethyl) glycine) has been sprayed at 2 L ha⁻¹, four days before planting wheat to control post emergent weeds. A fertilizer rate of 100 kg ha⁻¹ DAP (di-ammonium phosphate) and 100 kg ha⁻¹ urea was applied. And the method of planting was by broadcasting of wheat for both practices (*DER+* and CT). However, weed control in CT was done by repeated tillage and hand weeding.

2.3 Farmer perception

Based on the selected target group, households who practiced on CA were interviewed and focus group discussion was made including the local agriculture experts of the Woreda to address farmers' perception on glyphosate application for weed control, their knowledge on CA and on herbicide uses and drawbacks. The questionnaire was translated to the local language 'Tigrigna', based on the variables like personal information and household data, social awareness and implementation of glyphosate and CA practice, their landholding status to CA and livelihood related information. The questionnaire was semi-structured (close ended for the individual households and open ended for the focus group discussion to come up with further ideas).

Table 1 Distribution of sampled households in both study sites

S/N	Name of <i>Tabia</i> (towns)	No. of CA practiced House holds
1	Hagereselam	7
2	Adigudom	9
Total		16

2.4 Economic analysis

A cost benefit ratio was calculated to compare between CA and CT systems in two locations. Total costs were taken starting from land preparation up to trashing of the crop yields. The net income was calculated as the difference between the total income and the total variable costs deserved (Imran *et al.*, 2013). Similarly, the cost benefit ratio was calculated as benefit cost ratio equal to the value of total income divided to the value of total cost (Imran *et al.*, 2013). The values of total income were from grain and straw yields and the variable costs were land preparation, herbicide application, seed, fertilizer, glyphosate, hand weeding, harvesting, crop residue retention and trashing costs. Time of plowing, spraying of herbicide to CA system and hand weeding was recorded for each tillage type on each farmers' plot for estimating the costs. Those and the other agricultural labour costs were estimated based on the farmers pay to obtain the input and the same to that for the straw yield. Costs of seed and fertilizer were estimated to be the same for both practices. The market price of the grain yield was obtained from the sellers in nearby towns of Hagereselam and Adigudom.

2.5 Statistical Analysis

The data collected from socio-economic survey were analyzed using SPSS 20 statistical software.

3. Result and discussion

3.1 Community Perception on Application of Glyphosate on CA

3.1.1 Farmer's perception on use of glyphosate

Generally in the two districts the total farmers involved in conservation agriculture were very few (Table 1). Farmers and the local agricultural experts pointed out that there was less Governmental and NGO's support for CA implementation. Three years ago, 31.3% of the farmers involved in *DER+* planting system did not perceive and not willing to proceed with the practice. Those farmers perceived that glyphosate was not effective to control weeds in CA-based systems. Similarly they said that the reductions in tillage frequency have increased weed infestation that leads to yield reduction. According to their explanation, they need continuous incentives. MU-IUC program, which introduce *DER+* and herbicide application had been given training and experience sharing to farmers and agricultural experts in the study area. However, there was a lack of continuous follow up on its implementation, expansion and less effort to encourage farmers. Similar to this result Nyanga *et al.* (2012) reported that less herbicide users in CA were due to the misunderstanding about the herbicide, economical

shortage and less convincing to the farmers about the weed control technique on CA. From the CA involved farmers, 68.8% of them are still carrying out CA tillage systems and they use glyphosate.

Table 2 Farmer perception on glyphosate application on *derdero* practice

Involved farmers in CA	Observed	Percent
Farmers that use glyphosate in DER+	11	68.8
Terminated DER+ farmers before 3 years	5	31.3
Total	16	100.0

DER+=*derdero*

3.2 Role of glyphosate on weed control

Sixty four percent of farmers who practiced glyphosate application to control weed responded that, glyphosate was an effective herbicide for weed management (Table 3). Also they said that, glyphosate was effective for grass and other perennial weeds which were problematic to manage by mechanical method in their agricultural farm. Similarly, a Chi-square (χ^2) test showed that there was a significant difference ($P= 0.001$) on the perception of farmers related to glyphosate application. Some of the interviewed farmers respond that the weed population density on their farm was not different from the previous local weed control techniques like hand weeding and frequent tillage. Despite those farmers also perceived positively due to its reduction in labour requirement for weeding and tillage.

Table 3 Perception on weed control by using glyphosate

Status of weed population	Farmers using DER+		farmers that used DER+ before 3 years		Total	
	Observed	Percent	Observed	Percent	Observed	Percent
Increased	3	27.3	2	40.0	5	31.2
Decreased	7	63.6	0	0	7	43.8
Nochang	1	9.19	3	60.0	4	25.0
Total	11	100.0	5	100.0	16	100.0

DER+=*derdero*

As shown in Figure 2, the respondents from Hagereselam perceived that glyphosate has not controlled weeds more than the local system. In DER+ system, crop residue has an additional role to weed control through suppressing weeds. However, according to the respondents and as we observed in the farmers' field of Hagereselam, there was a free grazing system and the crop residue was wasted after a few months. In addition the rate of glyphosate application might be not enough for the weed control on the farmer's field of Hagereselam. Those farmers also might have less awareness, less technical skill and not convinced about the effectiveness of the herbicide. While most of the respondents (77.8%) in Adigudom perceived that glyphosate was a best solution for the weed problem in DER+ (Figure 2). similarly, farmers in Adigudom had a positive understanding on the crop residue management especially in relations to soil fertility improvement.

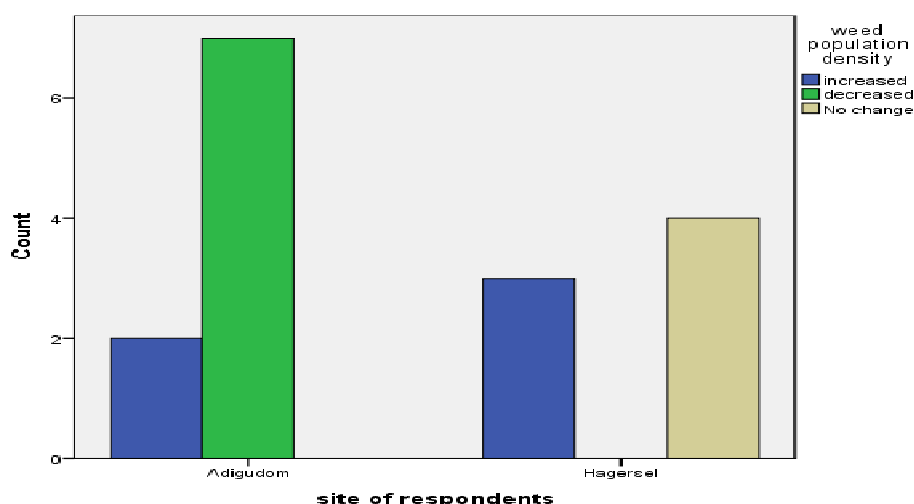


Fig. 2 Farmer's perception on weed control through glyphosate application

3.4 Economic benefits of glyphosate

The respondents of the interview stated that frequent tillage and hand weeding was the common weed control method in the village. Most crops, including wheat and barley were tilled at list three times and from 2-3 times

for weeding if there is no any herbicide application. As a result 68.8% of the respondents (Table 4) perceived that glyphosate use has reduced the family labour, hired labour, and time costs in their small farmlands. In the DER+ planting system, weeding and plowing cost were lower by 12.3% and 76.68%, respectively compared to the traditional tillage. Furthermore, they explained that glyphosate had a great contribution on increasing the income due to its effective weed control in DER+ planting system (Table 4). As the farmers compared their net benefit between their farms of DER+ and traditional farming system, higher net benefit (\$1136 ha⁻¹) were gained from the DER+ compared to traditional planting system (\$362.5 ha⁻¹) (Table 5). Twenty seven percent of the respondents said that even though the weed population density was increased; glyphosate had an advantage to eliminate some weeds like *cynodon* species which are difficult to control through tillage or hand weeding and then reduces labour and time cost.

Table 4 Perception on the economic advantage of glyphosate

	Current DER+ farmers		DER+ farmers before 3 years		Total	
	Observed	Percent	Observed	Percent	Observed	Percent
Benefit of glyphosate						
Beneficial	11	100.0	1	20.0	12	68.8
Not beneficial	0	0	4	80.0	4	31.2
Total	11	100.0	5	100.0	16	100.0

Table 5 Economic comparison between farmers DER+ practice and tradition planting

Planting system	Total Cost(USD ha ⁻¹)	Total income (USD ha ⁻¹)	Net benefit(USD ha ⁻¹)
DER+ practice	619.61	1755.76	1136
Traditional planting system	531	893.63	362.5

3.5 Environmental and ecological effect of glyphosate

As Table 6 indicates 87.5% of the respondents reported that CT in the study area was done three times per year. They said that, its advantage was to control weed, to loosen the soil and for favorable seed bed. On the other hand, they also described that the local weed control activities including plowing is exposes the land to the severe erosion and other additional land degradation. Similar reports were obtained by (Tatenda *et al.*, 2013). According to the interviewers perception glyphosate has a contribution to reduce this challenge through replacing intensive tillage to weed control. As the farmers explanation the application time of glyphosate is before planting (on the early summer). At that time, most agricultural crops could not germinate and the other forest plants do not start flowering and hence glyphosate has not a direct contact with them. Thus glyphosate has no any effect on animals or any non target plants and honeybees. However, all farmers did not use personal protective equipment on the time of herbicide application. This might be due to less awareness on safety issue.

Table 6 Farmer's perception on tillage frequency

PF on Wheat or barley	Plowing frequency on CT		Plowing frequency in DER+	
	Observed	Percent	Observed	Percent
2	1	6.3	1	100.0
3	14	87.5	2	0
4	1	6.3	3	0
Total	16	100.0	16	100.0

DER+=*derdero*, CT=conventional tillage PF = plowing frequency

3.6 Conclusion

Based on the assessment of farmer's perception, application of glyphosate before crop emergence on CA-based systems reduces weed infestation. The weed management with glyphosate application in CA, the minimum tillage and crop residue management was essential for the significant increase of farmers' agricultural income. Additionally Glyphosate application in the farmers' CA-based systems was economically beneficial with low ecological and environmental impacts that have the potential restoration of the degraded crop lands through the replacement of frequent tillage to weed control and helps to wide application of CA-based system in the region.

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