FINAL PROJECT REPORT

DETAILS

Project number		M106/81 (000375)
Project title		Evaluation of conservation agriculture as an alternative to conventional production methods as applied by a selected group of land reform beneficiaries of the Dipaleseng Municipality **(Balfour)** in Mpumalanga
Project manager		APN du Toit
Co-worker(s)	Internal	Dr AA Nel, Messrs EA Nemadodzi, MM Kola and TA Masiha
	External	Dr T Yu, Messrs J van Biljon and J Schoeman
Project status		Complete
Duration		01/04/2012 to 31/03/2017
Funder(s)		ARC/Maize Trust (CA)

Final abstract

The project was implemented to provide an alternative production system for target farmers (grain producers) in the Dipaleseng municipality. From the start, interaction with and participation by farmers were seen as essential components of the project. In order to achieve these objectives, fourteen interactive events were conducted. Through these training activities and in-field exposure to various aspects of crop production, participating farmers have gained much more insight and knowledge into CA and related practices. At the same time, on-farm experiments formed the core activity in the project and served as platforms for interaction and communication with the farmers. Valuable information such as relative yields of maize and soybean in the respective systems as well as rainfall use efficiency (RUE) was obtained. At the start of the project, the fear of a decline in maize yields was a major concern mentioned by most farmers in the target group. The fact that no decline in maize yields occurred in the case where CA was practised in the experimental plots (over three production seasons), is of particular importance at the completion stage of the project.

Keywords

Conservation agriculture, soil degradation, soil quality, on-farm experiments, farmer study group.

1. Introduction

The vast majority of soils in the target area have been exposed to many years of conventional soil tillage methods which resulted in soils of low quality i.e. soils with poor physical, chemical and biological status. Cropping systems in the target area are characterised by mono-cropping of maize to the expense of more sustainable practices such as crop rotation. In this context, CA is seen as the alternative, which can significantly, not only improve soil quality, but also contribute to more sustainable and economic viable farming units as opposed to the conventional system.

In order to start the project, twenty-two farming units (35 farmers) were selected which included 6186 ha of arable land. The farms are located in the districts of Balfour, Grootvlei and Greylingstad (Dipaleseng Municipality) in the South Western part of Mpumalanga. At the start of the project substantial evidence were available that some of these farmers have the necessary abilities and qualities to manage their farming units with success. Potential of the soil and the long-term climatic data indicate that the prospects for successful grain production in the target area are relatively good. The mean annual rainfall measured at two local rainfall-monitoring sites (24 years) varies between 691mm and 720 mm in terms of soil depth; 54 % of the soils were classified as medium deep to very deep and 46 % of the soils in the area were rated as medium to high potential.

Implementation of a well-tested and appropriate CA system was regarded as the best way to improve crop production in the targeted area. CA as opposed to conventional cultivation practices implies a significant reduction in soil tillage actions, improved soil water conservation, increased soil quality and input-cost savings. These effects of CA in turn have the potential to improve crop yields, increase profit margins and contribute to lower risks as crop performance stabilises. Increased production levels and profitability at a lower risk will motivate benefiting farmers to expand and grow their enterprises.

2. Material and Methods

Communication and interaction with target farmers:

Proper consultation with the target group preceded all actions in the project area. Preparation for change was seen as a fundamental principle of a sustainable development intervention. The establishment of a study group was also an important activity necessary to ensure effective communication and collaboration. The following two objectives, formulated in advance of the project, give a clear indication of the importance of collaboration with target farmers. The following were envisaged: a) To establish an environment for effective communication, interaction, shared responsibilities, accountability and mutual learning among participating farmers, and b) to expose farmers to the fundamental principles of CA through interactive training sessions and field excursions.

Natural resource survey and land use planning:

A natural resource survey is a prerequisite for any intervention of this nature. The information obtained in this way played an important role as a guideline for planning, land utilization and resource management. The survey and additional transfer and sharing of information was done by two experts (Pedologists) from the ARC-Institute for Soil Climate and Water (ARC-ISCW).

Ameliorate soil acidity and soil compaction at experimental plots:

When starting a CA system it is important, especially in cases where severe acidification occurs, to correct soil acidification prior to the establishment of the system. At the same time, any soil compaction layers identified at the experimental plots were to be uplifted.

On-farm experimentation:

On-farm experimentation is a form of adaptive research in which the technology is tested on the farmer's doorstep. It provides an opportunity for farmers to participate in the process of more appropriate technology development. As such, the experimental plots also serve as communication platforms to ensure effective interaction between researchers, extension workers and farmers. The CA experiments also compared conventional agronomical practices with CA practices in terms of soil preparation, soil surface protection, planting methods with specialised planters (no-till) and weed control practices. The emphasis was on CA as an integrated production system built on the three basic principles of minimum soil disturbance, establishment of an organic

soil cover and crop rotation. Two experimental plots were planted in 2012/13. At the start, acidification and soil compaction were corrected and in so doing, plots were prepared to establish the experiments the following season - 2013/14.

3. Results and Discussion

Communication and interaction with farmers:

The project management team strived to maintain a continuous flow of communication with farmers and stakeholders. As a result of training activities and in-field exposure to various aspects of crop production at various events (14 events since the start of the project in 2012), participating farmers have gained much more insight and knowledge. Apart from a strong message to promote the principles and practice of CA, there was also a strong emphasis on the correct application of the basic practices such as the importance of effective weed control.

However, the partly failure to establish an effective study group among farmers, was a serious constraint in achieving the objectives of the project. Table 1 gives an exposition of the 14 events purposefully arranged to interact with the target group.

Table 1: List of interactive events with farmers participating in the project

Event	Date	Number of farmers reached*
Project start-up meeting with farmers	14 Aug 2012	23
CA Training workshop directed to farmers	5 - 7 March 2013	32
Project planning meeting with farmers	11 Sept 2013	15
Feedback session on completed soil survey	24 Feb 2014	11
Farmers day at Noncedo experimental plot	12 March 2014	24
Bus tour to commercial CA practitioner*	19 June 2014	15
Pre-plant training on mechanization presented by staff of the ARC-IAE	19 - 21 Aug 2014	27
Farmer field day to visit various fields in the target area	10 March 2015	21
Pre-seasonal information session with the focus on CA (A joint venture with Land Care)	23 June 2015	23
Study group formation	28 July 2015	24
Pre-seasonal no-till planter training - Planter adjustment and calibration	17 Sep 2015	42
Farmer field day - Visit to local CA farmer**	13 April 2016	30

Event	Date	Number of farmers reached*
Project progress report. Feedback meeting with participating farmers	13 Sept 2016	18
Farmers day with visitors group from Limpopo	06 April 2017	64

*The aim was to reach at least the core group of farmers (35) at each event.

Natural resource survey and land use planning:
On 6 December 2013, the soil survey and land use planning conducted by ARC-ISCW, was completed. The following farming units were selected for the survey on arable land: Mpembe (300 ha), Noncedo (350 ha) and Mkosera (350 ha). A valuable information session was conducted in order to give feedback on the soil survey and to enlighten farmers on the findings of the surveys conducted.

Amelioration of soil acidity and soil compaction:
The lime applied in 2012 resulted in the pH (KCl) status in the top soil of both experimental plots to improve significantly. At Mpembe pH improved from a low 3.72 to 5.01 and the acid saturation declined from 13 % to 0.14 %. At Noncedo, the pH value changed from 4.1 to 4.68 and the acid saturation from 22% to 2.21 %. Soil compaction identified at the Noncedo experimental plot was uplifted in 2012 during the soil preparation stage.

On-farm experiments:
On-farm experiments formed the core activity of the project. It served as valuable platforms of observation and exploration of various cropping practices and CA in particular. Maize yields obtained in the 2014/15 production season were significantly lower than yields obtained in the previous season due to lower rainfall (Table 2). Rainfall measured from September to March in the 2013/14 season at Noncedo added up to 681 mm. In the 2014/15 season, rainfall measured over the same period added up to a mere 368 mm.

The production season of 2015/16 was marked by unfavourable climatic conditions particularly during the early stages of the season. The season turned out well due to good rains that occurred from January 2016. The total amount of rain measured at Noncedo from August to April was 675 mm compared to 368 mm the previous season.

The maize yield obtained in the 2015/16 season was significantly higher than the yield obtained in the 2014/15 season (Table 2). The dry and hot conditions prevailing at Noncedo at planting time resulted in a low plant density of 20 000 plants ha^{-1} for maize (the recommended plant density is 32 000 plants ha^{-1}). As the cultivar used in the experiment (PAN 6R-680R), is known for its prolificacy, the low plant density combined with the prolificacy of the cultivar, can be seen as important variables contributing to the significant increase in yield results in the 2015/16 season. At Mpembe, however, extreme unfavourable climatic conditions during planting time resulted in poor germination of both maize and soybeans. All activities at Mpembe were stopped in early January 2016.

It can be concluded that, after three seasons at the Noncedo experimental plot, there is no indication of a decline in yield in the case where CA was practiced (Table 2). In this way, the experiment made a substantial contribution to allay the fear of a decline in yield, as voiced by farmers at the early stages of the project.

Table 2 indicates the results obtained in the project over three seasons.

Table 2: Maize Yields at two experimental sites - 2013/14 - 2015/16 Seasons

Locality	Conven-tional (kg ha^{-1})	No-till/CA (kg ha^{-1})	Conven-tional (kg ha^{-1})	No-till/CA (kg ha^{-1})	Conven-tional (kg ha^{-1})	No-till/CA (kg ha^{-1})
	2013/14		**2014/15**		**2015/16**	
Noncedo	**4 795**	**4 882**	**2 462**	**2 753**	**5427**	**6490**
Mpembe	**4 025**	**3 571**	**1 458**	**-***	**-****	**-****

In view of limited and erratic rainfall patterns in South Africa, rainfall use efficiency (RUE) is a valuable measure of productivity under dryland conditions. RUE is the measure of a cropping system's capacity to convert rainwater into grain. In the 2015/16 season at Noncedo, the RUE value of the maize in the conventional system was 8.04 kg of grain/mm rain (5427 kg ha^{-1}/675mm) compared to the 9.61 kg of grain/mm rain (6490kg ha^{-1}/675mm) in the CA system. The previous season's low rainfall figure (368

mm) makes the RUE value even more significant as it is assumed that, as a result of the dry conditions late in the season, reserved water (plant available water) in the soil profile, did not make a significant contribution to the yields obtained in 2015/16. In view of the abovementioned figures, it can be stated that the CA system implemented at Noncedo showed a substantial improvement in terms of productivity and risk reduction when compared to the conventional system.

In the 2014/15 and 2015/16 seasons soybean was planted to implement crop rotation into the systems compared. During the two seasons that soybean was introduced into the system, it appears that soybean under the CA system does not perform better than in a conventional system (Table 3). In the planting season of 2014, however, a heavy rainstorm at Noncedo, soon after planting, caused the soil surface in the conventional plots (soil without a cover) to develop a crust (surface sealing). This resulted in poor germination and a low plant density of the crop (20 000 – 30 000 plants/ha). This implies that a soil cover, as achieved in CA, can make a significant contribution to prevent surface sealing and thus limit the consequence of poor germination of the crop. Table 3 gives an indication of the performance of the crop in two seasons.

Table 3: Soybean Yields - 2014/15 and 2015/16 seasons

Locality	Conventional (kg ha^{-1})	No-till/CA (kg ha^{-1})	Conventional (kg ha^{-1})	No-till/CA (kg ha^{-1})
	2014/15		2015/16	
Noncedo	-	1 184	2 296	2 158
Mpembe	1 637	1 578	-**	-**

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