APPENDIX 4:
PROGRESS REPORT
THE PROMOTION OF CONSERVATION AGRICULTURE IN THE NORTH-EASTERN FREE STATE – PHASE 1 (TWO STUDY AREAS)

For the period:
October 2016 to September 2017

Compiled by:
HJ Smith, R Steynberg, L Visser, G Trytsman and S Smalberger

In collaboration with:
Riemland (Reitz) and Ascent (Vrede) study groups

September 2017

GRAIN SA
GRAAN SA

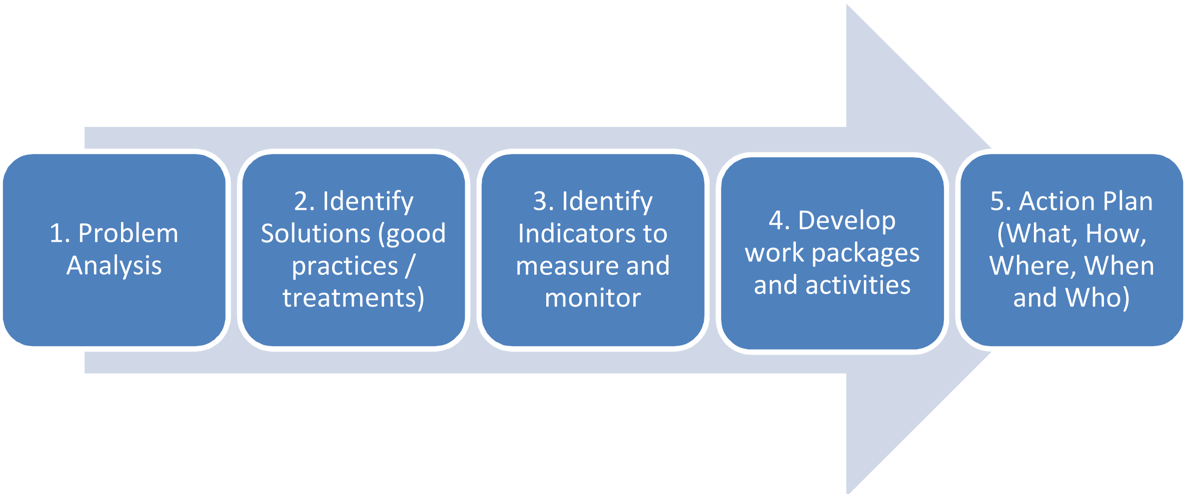
The Maize Trust

TABLE OF CONTENTS

1. Introduction

This progress report covers the period of October 2016 to September 2017 of the implementation of a project funded by The Maize Trust (MT)**,** which will assist to scale out Conservation Agriculture (CA) to grain farmers in the north-eastern Free State Province. The north-eastern and eastern parts of the Free State are seen as key grain producing areas and have very suitable conditions (soil and climate) to practice CA, however, the area still has a very low adoption percentage of farmers practising CA. Consequently, this area has been identified by Grain SA's CA Farmer Innovation Programme (CA-FIP) as a target area to promote CA among farmers in order to improve their sustainability and profitability. The Grain SA CA-FIP uses innovative, well organised and interested farmers and/or their structures (e.g. study groups, clubs, associations, etc.) as platform to launch projects and scale out CA to the surrounding farming communities. In this respect two active study groups, namely Ascent (Vrede district) and Riemland (Reitz district) have agreed to serve as platforms to launch projects in these two study areas. The study groups have consequently been engaged in various planning and implementation activities for the 2015/16 season, which have all been included in various work packages that serve as the framework for this proposal.

Central to the CA-FIP philosophy and approach, farmers' resource-base, experiences, practices, problems, fears, perceptions and needs form the basis of any proposed or intended (project) intervention to promote CA in a specific area. The 'learning process starts from what they know and where they are'. As a first step a 'diagnosis' of the situation was needed. The **aim of the diagnostic phase** was to assist stakeholders to analyse, describe and understand the current [farming] system or situation in need of change (to 'build a picture or model' of and to 'get a handle' on their situation in order to formulate effective solutions). There after a participatory planning session took place aiming to identify solutions or treatments to the problems, work packages and an immediate action plan. **Figure 1** below indicates the participatory diagnosis and planning process followed with the Riemland study group (on 18 August 2014 at the Mooigelegen farm, Reitz district) and the Ascent study group (on 19 August 2014 at the Ascent grain silo, Vrede district). These events were facilitated by Dr Hendrik Smith (CA Facilitator at Grain SA), assisted by Dr Sybrand Engelbrecht (CA research coordinator, The Maize Trust). Mr Willem Killian and Ms Lientjie Visser from the ARC-SGI at Bethlehem also participated in both events.
Figure 1: The participatory diagnosis and planning process followed with the Riemland and Ascent study groups



2. Description of the targeted study area(s)

The two study areas identified (listed below) were described in detail (Grain SA, March 2015).

The Frankfort-Vrede Plain occupies most of the northern half of the study area, south of the Vaal River. The underlying geology is mainly mudstone and sandstone of the Adelaide Formation, Beaufort Group with, in the north-east, shale of the Volksrust formation, Ecca Group. Dolerite intrusions occur frequently. The soils are mainly dark, swelling clays of the Arcadia form along with duplex soils (sandy, often bleached topsoil abruptly overlying gleyed clay) of the Estcourt and Kroonstad forms, especially in the north-west.

The Bethlehem-Reitz Basin, in the west of the area, is underlain mainly by mudstone and sandstone of the Tarkastad Formation, Beaufort Group. The soils here are mainly grey and yellow, sandy loam to sandy clay loam soils with grey, mottled plinthic subsoils, belonging to the Avalon, Westleigh and Longlands forms. Duplex soils, as well as shallow, rocky soils of the Mispah form, are also present.

3. Targeted beneficiaries or key project participants

Two separate farmer-centred Innovation Platforms (IP's) have been established around the Ascent and Riemland farmer study groups, which will target farming communities in the following Grain SA regions (and districts): Region 15 (Heilbron, Frankfort and Vrede) and Region 18 (Reitz and Lindley). Each of these two regions constitute fairly homogeneous agro-ecological conditions, which will facilitate the scaling out of CA practices from the representative project sites and trials on selected (or volunteering) farmers' fields (in the Vrede and Reitz districts).

It is envisaged that the IP's will be able to create a general awareness and innovation capacity among the farming communities in these regions and even beyond their borders. The official number of Grain SA members (grain producers) in these regions are 583 (region 15) and 371 (region 18), which have direct communication channels through the Grain SA structures and processes. Added to this is approximately the same number of non-member producers in these regions who are also seen as potential primary beneficiaries. Very few of these grain producers (<5%) follow CA practices, although a substantial (but unknown) percentage do follow some form of reduced tillage practice. The reasons for the poor adoption of CA is not well-understood, but are most probably and primarily due to a lack of information and awareness of the long term benefits of CA on farming and the environment. It is of utmost importance to break this cycle of ignorance and empower farmers with a truly sustainable farming system.

4. Project aim

The aim of the project is:
To promote conservation agriculture in key grain producing areas of the North-eastern Free State through a farmer-centred innovation process.

4.1. Objectives

The following short-term objectives will assist the project in achieving its aim:
a) To establish and facilitate on-farm trials around two local farmer structures (i.e. the Ascent and Riemland study groups)
b) To monitor and analyse a series of on-farm, farmer-led trials on selected farmers' fields
c) To create wider awareness and innovation capacity in local farming communities on the practices and benefits of locally adapted CA systems.
d) To support farmer facilitation, administration and reporting processes.

In order to effectively implement the above short-term objectives, a number of cross-cutting **work packages** were designed with each having a designated person or institution to implement and manage the specific activities and budget (see Section 11 below for detailed discussion of work packages). **Table 1** shows the different work packages and responsible champions in each project:

Table 1: Work packages and lead partners in Riemland and Ascent projects

Work Package	Lead partner - Riemland	Lead partner - Ascent
1. Coordination and management	Danie Slabbert (Riemland study group)	Paul Zietsman (Ascent study group)
2. Assessment of soil quality under CA systems	GP Schoeman (AgriSol); Willie Pretorius (Soil Health Solutions)	Paula Lourens (Vermi Solutions), Willie Pretorius (Soil Health Solutions)
3. Assessment of cover crop adaptability and suitability	Gerrie Trytsman (ARC-API)	Gerrie Trytsman (ARC-API)
4. Agronomic field trial planning, analyses and reporting	Willem Killian (ARC-SG)	Willem Killian (ARC-SG)
5. Coordination and facilitation of project activities among farmer participants	Suzette Smalberger (VKB)	Suzette Smalberger (VKB)

5. Project approach and rationale

In the original Grain SA proposal submitted in March 2015, the development and implementation of *Innovation Systems (IS)* to adapt CA principles to local (farmer) conditions has been well motivated and approved. Accordingly, and at the very least, the emphasis has to be on on-farm research and the inescapable experiential learning that this generates; both of which critically place the farmer in the central role.

Since the commencement of the implementation process in 2015, several 'actors' that influence the 'working' of the innovation process around the two project study areas, *have been 'formally' and effectively integrated with the IP's in the form of work packages and related responsibilities*. The CA FIP is confident that these two local IP's have their focus on **farmer empowerment**, i.e. ensuring that farmers are recognised, accepted, rewarded and used as independent innovators (or researchers). Proper facilitation and coordination of this farmer-led innovation process and its various activities is crucial and in the light of this IS philosophy, local resources (people) took up these responsibilities quite effectively. The CA facilitator at Grain SA (Dr Hendrik Smith), who manages and implements the CA-FIP, fulfils an overarching role in this respect. Another prominent local stakeholder, namely VKB, is playing a vital role at both sites as project or farmer facilitators, as well as implementing and monitoring field trials and other activities.

The key elements of the CA-FIP project approach are as follows:

5.1. Farmer-centred Innovation Systems Research

CA is defined by three key principles that have to be applied simultaneously and adapted to each farm ecosystem, namely minimal mechanical soil disturbance, permanent organic soil cover and crop diversity. The inescapable consequence of this is that farmers have to function as applied ecologists who have to fine-tune (adapt) universal principles to their own social, economic and ecological circumstances. As mentioned above, farmers are the adopters, the adapters and often the innovators of new farming techniques through an **on-farm, farmer-led research** process.

A series of selected on-farm, farmer-led trials, where farmers are lead or equal partners (in identifying research needs, designing, implementing and evaluating experiments), will give farmers independence, ownership and control. Experiments were well designed with appropriate treatments and sufficient replications spread over the entire agro-ecological zone and/or on a sufficient number of farms (see trial designs and layouts attached). Data from properly designed experiments will provide a much stronger starting point for discussion and investigation of a farmer's claims or problems. Hence, scientifically valid data are being generated and strengthened through the involvement of agricultural scientists in group problem solving and on-farm research (through the different work packages).

5.2. Participatory monitoring, evaluation and adaptive management

There are several purposes in the use of PM&E within the CA FIP, for example to enhance shared understandings (i.e. to offer a forum that allows different stakeholders to articulate their perspectives); to increase participants' engagement, sense of ownership, and self-determination; to strengthen organizations and promote institutional learning; to encourage institutional reform towards more participatory structures; etc. In this context PM&E is regarded less as an instrument of reporting and auditing, and more as a means of *enabling organizations and groups to keep track of their progress, build on their successes, and enhance their capacities for self-reflection, learning, and social responsiveness (or adaptability)*. Thus, PM&E is used in a more transformative / empowerment way to support learning and adaptive management among those involved.

The following indicators were identified and are being measured and monitored by and through the different work packages:

INDICATOR	**YES / NO**	**MEASUREMENT**	**WHO (Ascent)**	**WHO (Riemland)**
Compaction	Y	Root evaluation; bulk density; penetration resistance	Facilitator	Facilitator
Wind erosion	Y	Ground cover after plant (per Monitoring form)	Farmers & Facilitator	Farmers & Facilitator
Soil fertility	Y	Macro and micro nutrients – on row and in-between	Vermi Solutions	Agrisol
Soil biology / Soil structure	Y	%C / SOM / MO/ C02 soil respiration – different depths every 3-4 yrs	Soil Health Solutions	Soil Health Solutions
Rainfall	Y	Per event / 24 hour	Rain gauge	Rain gauge
Pests	Y	Monitoring form	Farmers & Facilitator	Farmers & Facilitator
Diseases (soil-borne)	N	Monitoring form	NA	NA
Nematodes	N	Nematode counts	NA	NA
Production	Y	Yield; kg/mm; kg/kg NPK; biomass	Farmers & Facilitator	Farmers & Facilitator
Weeds	Y	Weed counts; keep plots clear of weeds; weed control / herbicide programme	Farmers & Facilitator	Farmers & Facilitator
Mico-toxins	N			
Economy	Y	Gross margin / savings of treatments / systems economy	Farmers & Facilitator	Farmers & Facilitator
Grain quality	Y	Grading	VKB	VKB

Record keeping	Y	Description of all physical and chemical practices on treatments	Farmers	Farmers
Water content	Y	Soil moisture probes	Facilitator	Facilitator

5.3. Reference Group

A Reference Group will be coordinated for the project by Grain SA. The Reference Group (comprising key, concerned and capable persons) is tasked to provide the project team with guidance and to assist the CA-FIP in monitoring progress and evaluating deliverables. The Reference Group is only required to act in an advisory capacity. At this stage the Grain SA CA working group fulfils this role.

Reference Group (or CA working group) meetings are scheduled twice a year (February and August). Progress reports for the preceding period and work programmes for the following cycle are tabled and discussed at these meetings.

5.6. Awareness and marketing

General awareness (or sensitisation) has been experienced as particularly important to stimulate farmers getting involved with further learning activities, such as experimentation. The whole CA farmer innovation process usually needs an 'impulse' or an injection of energy (knowledge) to start or to speed-up the momentum and mostly it is a specific awareness event or sensitisation that achieves that. The CA-FIP sees three distinct awareness raising activities as key events during the entire CA innovation process:

- Organise cross-visits or Look & Learn visits to other successful CA communities or farmers
- Develop/distribute posters, pamphlets, videos/dvd's and other material to support the awareness raising events/campaign.
- Organise/support major or annual information days, workshops or conferences.

6. Work packages

As discussed above, a number of key stakeholders, who could play a role in the implementation of the project, were identified and involved at the start of the project. These stakeholders were invited to a planning workshop where they took part in a participatory brainstorm, identifying and prioritizing problems and solutions, consequently leading to the design of a number of Work Packages (WPs) to be implemented by selected stakeholders who were identified through these meetings. The project budget was consequently developed around these WPs, linked to various activities and deliverables. The implementation of these WPs is collectively monitored and managed through the project team, especially during site visits and monthly meetings. The on-farm trials form the basis of all the other activities in the project and will run through a number of seasons. Emphasis will be placed on data collection, interpretation, reporting and awareness.

7. Implementation of work plan from October 2016 to September 2017– summary

KEY ACTIVITY	TIMELINE	INDICATOR OF SUCCESS	PROGRESS TO DATE (for interim period Jul-Sep'15)
Objective 1: To establish and facilitate on-farm trials around two local farmer structures (i.e. study groups)			
a) Prepare, establish and manage on-farm trials on selected sites (farms)	Continuous	Statistically designed trials established and managed on selected trial sites	Statistically designed trials were designed, established and managed on selected trial sites. ARC SG helped the Riemland group to measure and prepare the trial sites. Assistance was also given with the planting of the row width trial. – see trial layouts attached
Objective 2: To monitor and analyse a series of on-farm, farmer-led trials on selected (volunteering) farmers' fields			
a) Participatory monitoring / data collection	January to June	Collection of a range of selected indicators from trials, especially soil samples	Collection of a range of selected indicators from trials, especially soil samples. VKB and ARC-SG sampled soil at all the trials to measure moisture at planting time.
b) Farmer participatory M&E and discovery learning	January to June	Completion of Field monitoring form with farmers	Completion of Field monitoring form with farmers. ARC-SG helped farmers to identify a fungus which was observed on maize stubble.
c) Data Analysis and Evaluation	June to August	Analysis of data collected from on-farm trials and field forms	Analysis of data collected from on-farm trials and field forms.
Objective 3: To create wider awareness and innovation capacity in local farming communities on the practices and benefits of locally adapted CA systems.			
a) Annual farmers day or conference	February to March	A well organised and -attended awareness event	A farmers' day (green tour) was successfully held in Reitz on 16 March, which was attended by 150 participants. A successful farmers' day was also held at Ascent on 24 August with 180 people attending.
b) Exposing on-farm trials to interested farmers and other	Continuous	Trial visits by interested people	A number of interested people (mostly farmers) have been visiting the on-farm trials through the season and had discussions with participating farmers.

Objective 4: To support social learning, farmer facilitation, administration and reporting processes.			
a) Project meetings	Bi-monthly meetings	At least six project meetings per year	A number of project meetings were held at each of the project sites to monitor and manage planned activities.
b) Farmer facilitation	Continuous	Effective deployment of a local farmer facilitation to assist implementation and M&E with farmers	Two farmer facilitators were identified to facilitate and coordinate activities with and between the farmer co-workers, namely Suzette Smallberger (VKB, with Riemland) and Robert Steynberg (VKB, with Ascent). Robert retired by end September and will be replaced by Jacques van Zyl (VKB).
c) Reference Group	August	A well organised annual reference group meeting	A number of feedback and planning meetings were held in August and September 2017.
d) Reporting	March and September	Six-monthly and annual reports according to specifications	Completed annual reports for period October 2016 to September 2017.

8. Implementation of work packages from October 2016 to September 2017

8.1. Coordination and management

Work Package title	**Coordination and management**
Work Package period	October 2016 to September 2017
Lead partner	Riemland and Ascent study groups
Involved partners	All
Objectives	Coordinate activities among all partners Ensure timely reporting to Grain SA Promote synergy among project activities
Justification	Project size, complexity and level of integration/interdependency among different project actions require strict delivery and adherence to project timelines as essential. Partners must often work together to achieve specific project outputs.

Description of work	**Project inception workshop**. A one-day project planning and inception workshop was held at the beginning of the project to enable all project partners to define work packages and procedures to achieve the project outputs and objectives. These WP's are used for the financial control and payment of the project and for the monitoring of the agreed tasks and deliverables. Work package managers were identified at this meeting and will present/follow strategies and protocols which are frequently monitored by all partners. **Frequent coordination meetings**. The purpose of these monthly or bi-monthly meetings is to establish and manage an Innovation Platform (IP) for improved communication, integration and sharing. The essence or key action in these meetings will be social learning, characterised by feedback, reflection, planning and coordination between different work packages and stakeholders. A secondary activity is the creation of a wider network in support of communication, sharing, learning and scaling out. **Annual Reference Group Meetings.** Formal reference group meetings will be organised each year with representation from each work package. In order to provide the project with independent monitoring, advice and support and to ensure communication with key stakeholders, a group of experts and end users (reference group) will be formed and invited to participate. Presentations from each work package leader will summarise achievements. Discussions about progress, potential deviations from the work plan and forward planning will be standing items at each meeting. **Activity reporting.** Partners will prepare a two-page activity report *every six months*. The lead applicant and work package managers will use these to assess whether work progresses to plan and take action to minimise the effects of delays on other project activities. **Annual progress reports.** Annual reports will be made following Maize Trust / CA-FIP instructions. Work package managers will be responsible for collating information and making a single work page report. The lead applicant will be responsible for integrating these into a single full report. A similar approach will be used to prepare the final project report covering information from all project years.

Deliverables	• Project actions and reporting delivered on time

Risks	None anticipated

8.2. Assessment of soil quality under CA systems

Work Package title	**Assessment of soil quality under Conservation Agriculture (CA) systems**
Work Package period	October 2015 to September 2017

Lead partners	AgriSol (Mr. GP Schoeman), VermiSolutions (Ms. Paula Lourens) and Soil Health Solutions (Mr Willie Pretorius)

Involved partners	Riemland & Ascent study groups, ARC-SGI, Grain SA,

Objectives	• To characterize the soil types and soil physical & chemical parameters, such as particle distribution, pH, Soil Organic Matter (SOM), macro-, micro-nutrients, and soil biology • To compare the effect of different CA treatments on soil quality • To establish relationships between different soil parameters, yield and atmospheric elements

Justification	A number of studies suggest that a soil and nutrient management strategy based on a broader range of ecosystems processes is worth further investigation. The approach shifts the emphasis of soil nutrient (fertility) management away from soluble, inorganic plant-available pools to organic and mineral reservoirs that can be accessed through microbial and plant mediated processes. However, a relatively poor understanding and capacity exist among the local research fraternity to investigate these crucially important subjects.

Description of work	Characterise the effects of different CA practices (treatments) on soil nutrient and physical dynamics as well as crop growth and yield, will involve regular field visits, sampling of soil on selected transects / sites and time intervals, laboratory analyses of the samples, data processing, statistical analyses and report writing.

Activities	1. Monitoring and Sampling 2. Lab Analyses 3. Monthly meetings (project team) 4. Annual reference group meeting (advisory committee) 5. Annual report and admin (technical data) 6. Participate in Awareness events

Risks	• Being a dryland experiment, low and erratic rainfall may compromise crop yields; • Wild animals and birds may jeopardise crop performance and yields; • Instrumental failure can result in incomplete data results

ACTIVITIES AND DELIVERABLES

Activities	**Deliverables**
1. Monitoring and Sampling	Soil classification (types and depths) Detailed sampling of each trial site; Selected samples in surrounding landscape Root evaluations in soil profiles
2. Lab Analyses	Organic C (%) Standard soil analysis: 4 basic cations, P, pH, ratios, micro-elements Texture (once-off, top- and subsoil) Soil biology (Solvita and others)
3. Monthly meetings (project team) & Training	Participate in monthly forum meetings, discussing problems and possible solutions to that.
4. Annual reference group meeting (advisory committee)	Report progress and findings to advisory committee; Discussion and evaluation of data. Learning from each other.

5. Annual report and admin (technical data)	Written technical report covering trial procedures, results and progress.
6. Participate in Awareness events	Trial visits with stakeholders; participate in awareness events, such as information day and/or cross-visits

DELIVERABLES, PROGRESS AND RESULTS ACHIEVED PER ACTIVITY

Activities	**Progress and Results achieved**
1. Monitoring and Sampling (Done with activity 3 above)	Monitoring done in September 2017
2. Lab Analyses	Waiting for analysis.
3. Monthly meetings (project team) & Training	Participated in planning meetings.
4. Annual reference group meeting (advisory committee)	Held in August and September.
5. Annual report and admin	Submitted 6-monthly report in March 2017 Contributed to comprehensive annual report in September 2017.
6. Participate in Awareness events	Participated in green tour (Riemland) on 16 March and farmers' day (Ascent) on 24 August.

8.3. Assessment of cover crop adaptability and suitability

Work Package title	**Assessment of cover crop adaptability and suitability**
Work Package period	October 2015 to September 2017
Lead partner	ARC-API (Mr. Gerrie Trytsman)
Involved partners	Grain SA, Riemland & Ascent study groups / IP's
Objectives	• To establish and maintain an on-farm screening trials • Determining the biological production of different cover crops • Measuring the production of crop residues of each cover cropping system • Measure the adaptability of cover crops in different agro-ecological regions
Justification	Cover crops offer many benefits for agriculture productivity and sustainability while reducing off farm environmental effects. For agricultural productivity, sustainability and soil health these include: erosion control, compaction remediation, increased water infiltration and storage, improved soil biodiversity, increased organic matter, nitrogen fixation, and improved nutrient recycling and

	retention of macro and micro nutrients. Environmental benefits include: reduced nutrient leaching, reduced sediment and phosphorus deposition, reduced runoff, and increased carbon sequestration; while suppression of weeds, diseases and nematodes and improved beneficial insect habitat results in reduced pesticide use. Other conservation benefits include: pollinator enhancement, wildlife enhancement as well as aesthetic value (Stivers-Young and Tucker, 1999; and Snapp *et al.,* 2005). The use of no-tillage systems greatly increases the benefits of cover crops and vice versa. No-till systems increases water conservation by maintaining cover crop residues on the surface. No-till systems reduce the disruption of the soil reducing: soil erosion, water runoff, organic matter oxidation and increases; infiltration and all of the benefits of improved organic matter accumulation. Stratification of the soil profile as result of no-till is important for macro invertebrates and soil micro-organisms. Tillage leads to unfavorable effects such as: soil erosion, soil compaction, loss of organic matter, degradation of soil aggregates, death or disruption of soil microbes and other organisms including; mycorrhizae, arthropods, and earthworms. Continuous no-till needs to be managed very differently in order to maintain or increase crop yields. Residue, weeds, equipment, crop rotations, water, disease, pests, and fertilizer management are just some of the many details of farming that change when switching to no-till. Tillage generally increases the amount and speed of nitrogen mineralization of soil organic matter which may increase or decrease synchrony of nitrogen release depending on the timing of the subsequent crop's nitrogen needs.

Description of work	**On-farm, farmer-led screening trials: around 10 potential cover crops**

Activities	7. Land preparation (finding a suitable location, sourcing materials) 8. Purchase Materials & Equipment 9. Establishing and Planting of trials 10. Seasonal management and maintenance of trials 11. Monitoring and Sampling (including harvesting, biomass and yield determination, nutrient analysis) 12. Lab Analyses 13. Monthly meetings (project team) & Training 14. Annual reference group meeting (advisory committee) 15. Harvesting, biomass and yield determination, nutrient analysis 16. Annual report and admin (production & technical data) 17. Participate in Awareness events

Risks	Finding a suitable site for a trial of this magnitude Getting the right equipment and seed to do the job well Acts of God (drought, hail, etc.) Labour (weed control, harvesting, etc.)

ACTIVITIES AND DELIVERABLES

Activities	**Deliverables**
7. Land preparation	Weeding and management of cover crops prior to planting.
8. Purchase Materials & Equipment	Acquisition of seed, inoculum, stickers, implements, chemical inputs.

9. Establishing and Planting of trials	Established trial according to the field plan.
10. Seasonal management and maintenance of trials	Regular visits to the trial site for inspection of weeds and insect damage and control if needed. Top dressing of grass cover crops. Treatment of cover crop at appropriate time (usually before seed set) using appropriate equipment. Submission of technical report after each visit. Photos from trial during visits
11. Monitoring and Sampling	Completed data sheets for 1. Input cost 2. Germination 3. Cover % 4. Height of cover of each addition 5. Biological productivity t/ha^{-1}
12. Lab Analyses	C:N content of plant material
13. Monthly meetings (project team) & Training	Partake in monthly forum meetings, discussing problems and possible solutions to that.
14. Annual reference group meeting (advisory committee)	Report progress and findings to advisory committee; Discussion and evaluation of trials. Learning from previous mistakes.
15. Annual report and admin (production & technical data)	Written technical report covering trial procedures, results and progress.
16. Participate in Awareness events	Trial visits with stakeholders; participate in awareness events, such as information day and/or cross-visits

DELIVERABLES, PROGRESS AND RESULTS ACHIEVED PER ACTIVITY

Background

Farmers at both Riemland and Ascent study groups decided not to plant the screening trial proposed due to the weed pressure during the previous season.

At Reitz, Callie Meintjies planted a cover crop mixture after harvesting soybeans. He also used the natural cover of degraded veld (slangbos) to establish maize after spraying a 5% solution of Roundup. Ruhan Theunissen planted a winter cover crop mixture that was grazed with sheep with good results. He wanted to leave the soil bare until winter to plant cover crops again as green fodder. A proposal was made that he should think of planting a summer mixture to curb volunteer weed germination and also to stop water erosion during the rainy season. Millet and Cowpea seed was bought for this planting and the cost was carried by this project.

At Skulpspruit Izak Dreyer planted 300 ha of mixture during winter and also invested in buying an Equalizer no-till small seed planter. This planter was used to plant a variety of summer cover crop mixtures. Close co-operation between Izak and Barenburg seed company exist. Izak also planted soybeans after a wheat cover crop planted after soybeans that looked good in comparison to soybeans planted after maize with a winter fallow between plantings.

An interseeding planter was also built from an old planter to allow for intercropping of mixtures in standing crops such as maize. This practice allows the farmers to interplant grazing crops such as oats, vetch and radish for use as a possible grazing during winter season. This practise can take place when the maize is at knee height.

Paul Zietsman from the Ascent study group also received summer mixture seed to plant. At this stage he is still deciding if he wants to make silage, graze or just leave the material for a cover.

Ad-hoc events that took place is the visits to both locations to make a video of the CA practices done by local farmers. In early February there was an awareness visit by a VKB management team that investigated the development and expansion of CA practises in their area.

Activities	Deliverables	Progress and Results achieved
1. Land preparation (finding a suitable location, sourcing materials, action planning)	Description of natural resources. This will include positive and negative factors that can impact on plant growth. Selection of suitable site(s). Sourcing of seed, inoculum, stickers, implements, chemical inputs; Assessment of trial site; Plan and clarify the roles of all parties involved.	Both Farmers (Callie and Izak) decided not to plant the Cover crop screening trial due to weed presure. Callie planted a winter mixture after harvesting Soya's. He also used degraded veld to plant maize after applying herbicide. Izak planted 300ha of covers of different mixtures, both winter and summer annuals. Wheat was also planted as a cover crop. Seed was bought for Ruhan Theunissen to cover his soil after grazing a winter mixture with sheep. Seed was also delivered to Paul Zietsman for planting of cover crop mixtures. Danie Slabbert also recieved seed and planted a total of 10ha.
2. Purchase Materials & Equipment	Purchase seed, inoculum, stickers, implements, chemical inputs.	Seed was supplied by AGT foods, but seed for screening trial was never delivered to Callie. 150 kg Cowpea seed was supplied to Izak for intercropping into maize. Ruhan received seed for summer plantings of 10 ha. Paul Zietsman recieved seed to plant 5 ha. Seed was also delivered to Danie Slabert

3. Establishing and Planting of trials	Drawing up a field plan Experimental design discussed with ARC Biometric Unit. Established trial according to the field plan.	Farmers planted the seed at the different locations with commercial planters..
4. Seasonal management and maintenance of trials	Regular visits to the trial site for inspection of weeds and insect damage and control if needed. Top-dressing of grass cover crops. Treatment of cover crop at appropriate time (usually before seed set) using appropriate equipment. Submission of technical report after each visit. Photos from trial during visits	Sites were visited at Izak Dreyer twice during the growing season. Top-dressing inputs was made during such a visit. Paul Zietsman also fertilized his plantings. Pieter de Wet (VKB) visited Ruhan and Danie Slabbert on a regular basis and made report backs and took photo's. He will report on the sites. Trials at Izak were visited on 12/05 and on 11/09. Proposals were made how to improve the system.
5. Monitoring and Sampling	Completed data sheets for: • Input cost • Germination • Cover % • Height of cover of each addition • Biological productivity tha^{-1} (Dry Matter, DM) Harvesting, collecting and interpretation of data.	DM will be determined at a later stage. At the same time cover %, height of the cover and actual stand will be determine.
6. Lab Analyses	C:N content of plant material	Dried DM samples will be sent to the lab.
7. Monthly meetings (project team) & Training	Participate in monthly forum meetings, discussing problems and possible solutions	Three visits for discussions and feedback were undertaken during the growing season. On the 11/09 a report back meeting was attended and ideas exchaned. Meeting was held at the Riemland study group with Landbouweekblad and the involvement of the different rollplayer were discussed.
8. Annual reference group meeting (advisory committee)	Report progress and findings to advisory committee; Discussion and evaluation of trials. Learning from previous mistakes.	On-going process.
9. Annual report and admin (production & technical data)	Written technical report covering trial procedures, results and progress.	Technical progress report was submitted by middle March. Technical progress report will be submitted in September

10. Participate in Awareness events	Trial visits with stakeholders; participate in awareness events, such as information day and/or cross-visits.	A video of CA principals was made during a vissit to skulpspruit. An information day with VKB member during February to enlighten them about the implications of CA.

Riemland (Reitz)

At Callie Meintjies' field site, plate 8.3.1 shows the positive influence that winter cover crops had on surpressing weeds during the rainy season. The control plots at Callie received no cover crops and are infested with weeds (thistles). On the cover crop field, there was no erosion visible after receiving 160 mm of rain in a short space of time.

Plate 8.3.1: Maize doing well after winter cover crops

Plate 8.3.2 and plate 8.3.3 show where Callie is planting into a stand of "slangbos" (an alien invader specie) and after successful growth, the maize looks good on the degraded veld. Slangbos was sprayed with a 5 % Roundup solution before planting. Discussing the practises with Callie after harvest, he is adamant that in the future he will rather plant a summer cover crop after spraying the slangbos with herbicides to compete with the weeds. If possible, he would also plant a winter cover crop after the summer cover to complete a full-year cycle. The yield that materialized after this innovation was a mere 4,2 t/ha, while on his ordinary fields a yield of 7,5 t/ha was harvest. The hypothesis is that a (biological) soil restoration process using cover crops would possible yield positive results in terms of soil health and crop productivity.

Plate 8.3.2. Planting maize into slangbos with a no-till planter

Plate 8.3.3: A successful maize stand planted on degraded 'slangbos' veld

Ruhan Theunissen obtained an excellent net margin (R4600/ha) with lambs on winter cover crops. He also established a summer cover crop and according to the VKB researcher, Pieter De Wet, the cover crops established well. Summer crops were recommended in stead of leaving the soil bare during the summer months. Problems with weeds and erosion were envisaged during rainy events, while productivity would have been far from optimal (if nothing was planted in summer). He expressed his gratitude with the suggestion. The following is an abstract from an article that was published in *Landbouweekblad*:

According to Ruhan "In *the summer of 2016/17 Grain SA (via the CA farmer innovation programme) was willing to provide seed for a summer cover crop mix in the Eastern Free State. The main goal of the trial was to see if a summer cover crop will help build cover and organic matter faster than only a winter cover crop. The goal was also to gauge how well it would fare as pasture for sheep grazing.*

A mix of Pearl Millet (Babala), Cowpeas, Jap Radish and a small number of sunflowers were planted. The summer mix was planted straight into the existing winter cover crop that has died off.

Growth was slightly stunted despite good rains throughout the summer. Soil samples showed sufficient P and K levels which only leaves Nitrogen as a controlling factor. No fertilizer was applied prior to or during the summer. It was concluded that a lot of nitrogen could be tied up in the winter cover's residue.

Sheep was introduced in late summer to graze the planted pasture. Millet was preferred over forage sorghum. The less tall millet allow sheep to move in more easily and graze it. Millet also has a lower risk of nitrate and HCN poisoning. After the first frost in fall the entire mix also made a good standing hay. The sheep were only briefly taken out during the wilting phase to avoid potential nitrate poisoning.

Based on the results and experience a summer cover/pasture crop will be brought in as a rotation with winter cover/pasture mixes. The millet and cowpeas left a good stubble even after grazing. It contributed to a better cover than winter cover crops alone and helped to control weeds during the summer."

Ascent (Vrede)

Izak Dreyer planted Soybeans after establishing wheat as a cover crop. Weeds were suppressed and the inoculation of the Soybean in the low N conditions was phenomenal as can be seen in Plate 8.3.4. shows that planting Soybeans into green cover has been done successfully. Killing the wheat (with herbicide) two weeks before planting had the desired effect.

Plate 8.3.4: Soybeans planted in rotation with wheat cover crop

Plate 8.3.5 and 8.3.6 resemble two summer cover crops mixtures planted by Izak at different locations. In Plate 8.3.6 the species composition is dominated by Teff which completely suppressed the Sorghum and Babala in the mixture. At steep slopes like these one would prefer a mixture that has good mulching properties, such as Babala, which contains a lot of lignin, cellulose and hemicellulose. In the next season, trials will include summer cover crops as well as winter cover crops in succession, which will be established at Skulpspruit and a few other participating farmers from the Ascent study group. However, farmers should be careful for too much Teff in the mixture. Both these mixtures will be grazed using principles of ultra-high grazing density.

Plate 8.3.5: Good stand of summer cover crop mixture

Plate 8.3.6: Summer cover crops mixture dominated by Teff

Plate 8.3.7 is an example of a winter cover crop mixture intercropped into standing maize at Skulpspruit. The intercrop was inter-seeded at hip-height with a locally manufactured no-till planter. This is a new intervention with potential to establish and extent the principle of having continuous living roots in the soil. This practice will be implemented at an earlier maize growth stage in the next season to see if a better stand can be materialised. The aim is to plant cowpeas as well as temperate crops; the benefits that could be gained through this practice in terms of sustainability is high. This practice can contribute to animal integration, weed suppression and soil health in row crops.

Plate 8.3.7: Maize intercropped with winter mixture

Izak planted a winter mixture which consist of Oats, Rye, Vetch and Radish after harvesting Soybeans. This type of intensification is consistent with the principles of CA. This pasture was grazed during the winter early spring month with livestock (sheep and weaners). A good net margin realized and he is considering to continue with this practise in the future. Plate 8.3.8 is testimony of the success of such a system. Regrowth that is ready to be grazed again is shown on this photo, which was taken on the 13/09/2017.

More than half the soil in the area are black clay soil from the Arcadia soil form. These clays crack when getting dry due to the clay mineral type. These cracks allow air to enter the soil. This enhances the evaporation from the soil profile. Planting high biomass summer cover crops on these soils will prevent them to absorb sun energy due to the protection and the low albedo effect of the residues. Soil cover will also slow evaporation, will assist in soil restoration and eventually will prevent these soils from cracking that much. Animals grazing these cover crops can possibly help in closing these cracks by the crumbling effect when trampling the edges of the cracks. The management of these soils in a CA system will be important and could provide various benefits.

Plate 8.3.8 Regrowth of winter cover crops after been grazed

Paul Zietsman received the summer mixture of Sorghum, Babala, Cowpea, Sunhemp and tillage Radish too establish 5 ha. At this stage he is uncertain about using the cover crop, but according to him it is a success. Talking to him after the season he is exited with the high yields of 25 t/ha that realized. The Babala and sorghum produced a lot of biomass, while the rest of the mixture was planted too shallow. He suggested that he will start grazing the mixture between knee and hip height in the future. He made a mistake by waiting too long. The mixture was then cut for silage at a later stage. This practice removes a lot of valuable nutrients from the system if not return as manure.

8.4. Agronomic field trial results in Riemland study area

Work period	October 2016 to September 2017
Lead partners	ARC-SG (W Killian, L Visser) and VKB (P de Wet, S Smalberger)
Involved partners	Riemland study group and other Innovation Platform (IP) partners

Objectives	• To plan and design the on-farm maize plant population density trials • To plan and design the on farm crop rotation trials • To (statistically) analyse and report the results of the maize plant population density trials • To (statistically) analyse and report on the results of the crop rotation trials

Justification	Plant population density is one of relatively few variables that farmers can manage easily. Current recommendations for maize plant population were derived from trials under conventional tillage. Physically, the soil is very different in no-tillage than in tilled soil. This might require an adjustment in the plant population density of crops. Recommendations from elsewhere in the world is that plant population densities should be increased and row width should be decreased for no-till cropping. Crop rotation, another easily manageable variable, is one of the principles of conservation agriculture. No information on how crops respond to rotation in conservation agriculture systems in this semi-arid environment is available. Crop responses to changes in management and the environment is usually liable to interactions resulting in variation of the results, which might lead to wrong conclusions and recommendations. In order to generate scientifically sound recommendations on these two agronomical variables, proper planning and analyses of the results is needed.

Description of work	**Planning and designing of trials in collaboration with participating farmers and partners. Analyses of farmer collected results and reporting of findings.**

Activities	Planning of trials through the attendance of the frequent coordination meetings where aims and procedures will be discussed with farmers. Planning of trial layout and compiling of data sheets to be completed by participating farmers. Collection of data from farmers at the after harvest of the trials. Statistical analyses, interpretation, discussion and drawing of conclusions from the results. Presentation and reporting of the results to participants and MT as required.

Deliverables	• Annual trial plans and analysis report • Regular attendance of meetings • Reporting as required • Popular article once enough results have been acquired.

Risks	Adequate involvement and participation of farmers

DELIVERABLES, PROGRESS AND RESULTS ACHIEVED PER ACTIVITY

Activities *(as specified in Work Package or project proposal)*	**Deliverables or Milestones***(as specified in Work Package or project proposal)*	**Progress and Results achieved;** and/or **Problems and Milestones <u>not</u> achieved**(in report period)
1. Planning of trials	Farmer participation in meetings.	Reporting and planning meetings were held at Reitz on 20 July 2016. Data were discussed and farmer participants were confirmed.
2. Land preparation and planting of trials	Trials were planted as planned during October-November 2016 period	Assist farmers to lay out their trial plots. Prepared (calibrate and train) farmers on the trial treatments. Made sure land preparation (e.g. weeding) was done according to specifications. Made sure the correct type and quantity of production inputs were ready and used. Weather station data imported. Agrixtreme discussed weed management and product use with farmer co-workers. Prepared planters for planting. Moved planters and herbicide applicators between farmers for timely planting where necessary. Made sure farmers planted according to standard treatment specifications. Planted according to the treatments although certain barriers forced for some alterations; Armand Muller planted late. The wheat was harvested late and therefore delayed planting of sugar bean and sunflower. Crop rotation trial harvested on schedule and planting followed with above-mentioned complication being the only alteration to the trial plan.
3. Seasonal management and monitoring	* Some measurements were made such as leaf chemical analysis of a fertiliser trial and soil water contents of some	Assist farmers in weeding and pest/disease management Agrixtreme visited the trials at Reitz on a weekly base for weed management.

	soils that were tilled differently. * Yields and yield components will be measured after harvesting. * Soil probe data are monitored on a continuous basis.	Captured weather and crop growth data. Managed recorded Aquacheck soil moisture data. Harvesting of grain and record keeping of dry matter throughout the season on the crop rotation plots. Wheat grain quality analyses and yield assessments done by ARC-SG.
4. Monthly meetings (project team) & Training	Participate in monthly forum meetings, discussing problems and possible solutions to that.	Active discussions on a Whats App group. Farmer visits. Project team meetings and discussion sessions between farmer co-workers.
5. Awareness events	Create awareness of CA farming practices through events and reporting.	* A trial inspection (with Argentinean delegates) and participation in a video recording were done in January and February 2017. * A succesful CA Green Tour was held on 16 March 2017.
Reporting	Reporting as required and popular article once enough results have been acquired.	* A popular article was written and submitted in February 2017 to SA Grain for publication.

TRIAL 1

PLANTING DENSITIES OF CROPS PRODUCED IN CONSERVATION AGRICULTURE SYSTEMS IN THE EASTERN FREE STATE

GENERAL PROCEDURES

The trial was planted on Mr Danie Slabbert's farm, Van Rooyenswoning, in the Reitz district. The objective was to compare the influence of interaction between three row widths (50 cm, 76 cm and 100 cm) and four plant populations on the yield of maize (photo 8.4.1) and soy bean (photo 8.4.2) respectively. Both crops were planted in factorial blocks, with three replicates of the two randomised treatments (Tables 8.4.1 & 8.4.2). The soy bean and maize rotate on an annual base (Table 3).

Table 8.4.1: Maize treatments

Row width (cm)	Plant population (plants)			
50	20 000	40 000	60 000	80 000
76	20 000	40 000	60 000	80 000
100	20 000	40 000	60 000	80 000

Photo 8.4.1: The maize block with all the treatments

Table 8.4.2: Soy bean treatments

Row width (cm)	Plant population (plants)			
50	150 000	250 000	350 000	450 000
76	150 000	250 000	350 000	450 000
100	150 000	25 000	350 000	450 000

Three row width treatments of soy bean

50 cm	76 cm	100 cm

Photo 8.4.2: The row treatments of soy bean

Table 8.4.3: Trial layout in 2016

Soy bean		Maize
Rep 1		Rep 1
Rep 2		Rep 2
Rep 3		Rep 3

Both crops were planted on 23 November 2017. Maize plots were fertilised before plant with 15 kg/ha of Kannas (26) + 6% S; were planted with 170 kg/ha of 6:2:1 (31); and received an additional 170 kg/ha top dressing of 6:2:1 (31) during the season. No fertiliser was applied on the soy bean plots. Maize plots were harvested on 16 May 2017 and soy bean plots on 20 April 2017.

Results

The planters could not realise the 20 000 × 50 cm maize treatment and was the treatment was replaced with a 40 000 × 50 cm treatment. Therefore, the 20 000 treatment was removed from the data set.

1. Plant emergence %

Table 8.4.4 indicates that the emerging percentages of maize treatment combinations did not differ.

Table 8.4.4: Maize emergence %

Plant population	Row width (cm)			Average
	50	**76**	**100**	
40 000	77[a]	87[a]	59[a]	74[a]
60 000	82[a]	77[a]	41[a]	67[a]
80 000	71[a]	70[a]	51[a]	64[a]
Average	77[a]	78[a]	50[b]	*68*
$LSD_{(plant\ pop.\ X\ row\ width(0.05))}$: 21, $LSD_{(plant\ pop(0.05))}$: 12, $LSD_{(row\ width(0.05))}$: 12, cv: 18.1%				

Row width had no influence on plant emergence of soy bean (Table 8.4.5). The average soy bean emergence % of the 150 00 population was however significantly higher than the emergence % of the 450 000 × plant population. The treatment combination of 450 000 × 50 cm row widths also resulted in a significant lower plant emergence of 59% in comparison to the 118% plant emergence of the 250 000 × 50 cm rows. The plant emergence of the 150 000 × 100 cm rows was significantly higher than the plant emergence percentages of the two highest plant populations in the 100 cm rows. It can be concluded that plant population had a bigger impact than row width on soy bean emergence during the 2016/2017 season.

Table 8.4.5: Soy bean emergence %

Plant population	Row width (cm)			Average
	50	**76**	**100**	
150 000	87[ab]	89[a]	119[a]	98[a]
250 000	118[a]	53[a]	69[ab]	80[ab]
350 000	72[ab]	53[a]	51[b]	59[bc]
450 000	59[b]	56[a]	33[b]	49[c]
Average	84[a]	62[a]	68[a]	*71.4*
$LSD_{(plant\ pop.\ X\ row\ width(0.05))}$: 53, $LSD_{(plant\ pop(0.05))}$: 31, $LSD_{(row\ width(0.05))}$: 26, cv: 43.7%				

2. Yield

Table 8.4.6 shows that plant population had no influence on the maize yield, while the average yield of the 50 cm rows were significantly higher than the average yield of the 100 cm rows. However, the yield of all the treatment combinations did not differ significantly.

Table 8.4.6: Maize yield (12.5 moisture) ton/ha

Plant population	Row width (cm)			Average
	50	76	100	
40 000	7.84[a]	7.42[a]	6.15[a]	7.14[a]
60 000	8.03[a]	8.09[a]	6.99[a]	7.70[a]
80 000	9.25[a]	7.44[a]	6.57[a]	7.75[a]
Average	8.37[a]	7.65[ab]	6.57[b]	*7.53*
$LSD_{(plant\ pop.\ X\ row\ width(0.05))}$: 2.60 $LSD_{(plant\ pop(0.05))}$: 1.50, $LSD_{(row\ width(0.05))}$: 1.50, cv: 20%				

Row width and population had no impact on soy bean yield (Table 8.4.7). The only significant difference observed was between the 3.60 ton/ha of the 350 000 × 100 cm treatment and the 2.32 ton/ha of the 450 000 × 100 cm treatment. These results should be confirmed with more data in the next growing season.

Table 8.4.7: Soy bean yield (ton/ha)

Plant population	Row width (cm)			Average
	50	76	100	
150 000	2.53[a]	2.36[a]	3.46[ab]	2.78[a]
250 000	3.13[a]	2.97[a]	2.75[ab]	2.95[a]
350 000	2.47[a]	3.02[a]	3.60[a]	3.03[a]
450 000	3.11[a]	3.35[a]	2.32[b]	2.93[a]
Average	2.81[a]	2.93[a]	3.03[a]	*2.92*
$LSD_{(plant\ pop.\ X\ row\ width(0.05))}$: 1.09, $LSD_{(plant\ pop(0.05))}$: 0.63, $LSD_{(row\ width(0.05))}$: 0.55, cv: 22%				

Planning for 2017/2018 season

A planning meeting was held on 30 August 2017 with the famers involved in the trial. All the role-players are on board with their responsibilities. Mr Callie Meintjies sold his planter, but Mr Abe Visser will assist with planting of this specific trial. The 20 000 maize plant population will be replaced with a 100 000 stand. All the role players committed themselves to be present at the trial on the day of planting.

TRIAL 2

AN EVALUATION OF DIFFERENT CROP ROTATION SYSTEMS IN THE EASTERN FREE STATE

GENERAL PROCEDURES

Two replicates of the trial were planted on the farms of Mr Danie Slabbert and Mr Armand Muller. Both trials were planted as randomised blocks, with four replicates of six crop rotation system treatments (Table 8.4.8). The six rotation systems include the following crop sequences:

- Soy beans : Maize
- Soy bean : Wheat : Sunflower : Maize
- Soy bean : Wheat : Maize
- Soy bean : Sunflower : Maize
- Soy bean : Winter cover crop : Maize
- Soybean : Wheat : Sugar bean : Maize

Table 8.4.8: Trial plan with four replicated blocks of the six crop rotation system treatments

Replicate 1		Replicate 4
6 Soy bean : Wheat : Sugar bean : Maize		1 Soy bean : Maize
4 Soy bean : Sunflower : Maize		2 Soy bean : Wheat : Sunflower : Maize
1 Soy bean : Maize		6 Soy bean : Wheat : Sugar bean : Maize
2 Soy bean : Wheat : Sunflower : Maize		3 Soy bean : Wheat : Maize
3 Soy bean : Wheat : Maize		5 Soy bean : Winter cover crop : Maize
5 Soy bean : Winter cover crop : Maize		4 Soy bean : Sunflower : Maize
Replicate 2		**Replicate 3**
3 Soy bean : Wheat : Maize		2 Soy bean : Wheat : Sunflower : Maize
6 Soy bean : Wheat : Sugar bean : Maize		4 Soy bean : Sunflower : Maize
5 Soy bean : Winter cover crop : Maize		1 Soy bean : Maize
2 Soy bean : Wheat : Sunflower : Maize		3 Soy bean : Wheat : Maize
4 Soy bean : Sunflower : Maize		6 Soy bean : Wheat : Sugar bean : Maize
1 Soy bean : Maize		5 Soy bean : Winter cover crop : Maize

Each rotation system is planted on the same plot per annum to measure the effect of the crop sequence on the specific plot. The crop sequences of the different rotation systems, as well as the specific months of planting is shown in Table 8.4.9.

Table 8.4.9: The six crop rotation systems with specific crop sequences and planting times

Year	Month	Rotation 1	Rotation 2	Rotation 3	Rotation 4	Rotation 5	Rotation 6
	Nov	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean
	Dec	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean
	Jan	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean
	Feb	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean
	Mar	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean
	Apr	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean
	3 May	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean	Soy bean
	Jun		Wheat	Wheat		Cover crop (W)	Wheat
	Jul		Wheat	Wheat		Cover crop (W)	Wheat
	Aug		Wheat	Wheat		Cover crop (W)	Wheat
	Sep		Wheat	Wheat		Cover crop (W)	Wheat
	Oct		Wheat	Wheat			Wheat
	Nov	Maize	Wheat	Wheat	Sunflower	Maize	Wheat
	Dec	Maize	Wheat	Wheat	Sunflower	Maize	Wheat
	Jan	Maize	Sunflower		Sunflower	Maize	Sugar bean
	Feb	Maize	Sunflower		Sunflower	Maize	Sugar bean
	Mar	Maize	Sunflower		Sunflower	Maize	Sugar bean
	Apr	Maize	Sunflower		Sunflower	Maize	Sugar bean
	May	Maize	Sunflower		Sunflower	Maize	Sugar bean
	Jun	Maize	Sunflower		Sunflower	Maize	
	Jul						
	Aug						
	Sep						
	Oct	Soy bean	Maize	Maize	Maize	Soy bean	Maize
	Nov	Soy bean	Maize	Maize	Maize	Soy bean	Maize
	Dec	Soy bean	Maize	Maize	Maize	Soy bean	Maize
	Jan	Soy bean	Maize	Maize	Maize	Soy bean	Maize
	Feb	Soy bean	Maize	Maize	Maize	Soy bean	Maize
	Mar	Soy bean	Maize	Maize	Maize	Soy bean	Maize
	Apr	Soy bean	Maize	Maize	Maize	Soy bean	Maize
	May	Soy bean	Maize	Maize	Maize	Soy bean	Maize
	Jun		Maize	Maize	Maize	Cover crop (W)	Maize
	Jul					Cover crop (W)	
	Aug					Cover crop (W)	
	Sep					Cover crop (W)	
	Oct	Maize	Soy bean	Soy bean	Soy bean	Maize	Soy bean
	Nov	Maize	Soy bean	Soy bean	Soy bean	Maize	Soy bean
	Dec	Maize	Soy bean	Soy bean	Soy bean	Maize	Soy bean

- **The red line indicates the next plating season in 2018/2019**

Agrixtreme was responsible for weed management of the trials and paid regular monitoring visits. Drifting problems occurred due to the smaller plot sizes and equipment was adapted to address the problem (Photo 8.4.3).

Photo 8.4.3: The sprayer was boxed on the sides to prevent drifting to other plots

Tables 8.4.10 and 8.4.11 list the seeding density and fertiliser application rates on both farms. Low soil moisture detain Armand from planting sugar bean and early sunflower in rotation systems four and six (Table 8.4.11).

Table 8.4.10: Crop and fertiliser information of crop rotation trial on Danie's farm

Crop	Cultivar/ variety	Seeding density	Fertiliser	Fertiliser – application rate
Soy bean	PAN 1454	300 000 seed/ha	Before plant: KANNAS (26)	 100 kg/ha
Wheat	PAN 3479		2:2:1 (34)	150 kg/ha
Cover crop	*Winter mix	-	Not fertilised	-
Sunflower	CLP 7095	40 000 seed/ha	Before plant: KANNAS (26) Plant: 8:2:1(30) Top dressing: 6:2:1(31)	 80 kg/ha 140 kg/ha 140 kg/ha
Sugar bean	DPO OPrs4	60 kg/ha		*
Maize	DCK 71-44BT	40 000 seed/ha	Before plant: KANNAS (26) Plant: 6:2:1(30) Top dressing: 6:2:1(31)	 115 kg/ha 170 kg/ha 170 kg/ha

*Ray, wheat, vetch, radish, saia, turnips & oats

Table 8.4.11: Crop and fertiliser information of crop rotation trial on Armand's farm

Crop	Cultivar/ variety	Seeding density	Fertiliser	Fertiliser – application rate
Soy bean	PAN 1454	32 kg/ha	Not fertilised	-
Wheat	SSK317	40 kg/ha	3:2:1	135 kg/ha
Cover crop	*Winter mix	-	Not fertilised	-
Sunflower	CLP 7160	50 000 seed/ha	2:2:1(34) +5%zn, 4%S	130 kg/ha
Sugar bean	Not planted	-	-	-
Maize	DCK 73/72	42 000seed/ha	2:2:1(34) +5%zn, 4%S	180 kg/ha

*Ray, wheat, vetch, radish, saia, turnips & oats

The trails started in November 2015 with soy bean on all the plots. Wheat and a winter cover crop mix were planted in June 2016 on plots of crop rotations systems two, five and six. The wheat was harvested in December 2016 and the cover crop were terminated in September 2016 (Photo 8.4.4).

Photo 8.4.4: Terminated cover crops

Maize and sunflower were planted in November 2016 on soybean in rotation systems one, four and five respectively, while sunflower and sugar bean were planted in January 2017 as catch crops on wheat in rotation systems two and six. The sugar bean was harvested in May 2017 and the other summer crops in rotation systems one, two, four and five in June 2017.

RESULTS

Van Rooyenswoning received 316.5 mm rain from October 2015 to April 2016, in comparison to the 618.3 mm, which was measured for the same period in the 2016/2017 season (Table 8.4.10). The low rainfall resulted in a poor soy bean harvest on both trials (Tables 8.4.13 to 8.4.18) in May 2016.

Table 8.4.12: Monthly rainfall measured at Van Rooyenswoning from October 2015 to April 2017

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2015										20	22	34
2016	102	58	45	35.5	32.5	6.3	56	7.2	9.3	94.5	165.3	87
2017	104.4	143.1	24	0								

Wheat and a winter cover crop mix were planted as the next crop sequences on rotation systems two, three, five and six. Danie planted the wheat cultivar PAN 3479 on 12 July 2016 and Armand SSK 317 on 10 August 2016. Not much rain fell after the soy bean harvest and low stored soil moisture resulted in average wheat yields of 1.03 ton/ha, 1.20 ton/ha and 1.33 ton/ha respectively. The wheat yields harvested on Danie's farm were significantly lower than the yields obtained on Armand's farm (Tables 8.4.14, 8.4.16 & 8.4.17). The difference could be due to planting date, or cultivar differences. The dry plant mass yields of the cover crop plots were obtained after termination in September 2016 (Table 8.4.18). Dry plant mass yields of the two trials did not differ significantly.

Low soil moisture detained Armand from planting sugar bean and sunflower as catch crops in rotation systems two and six. Danie harvested an average of 0.28 ton/ha sugar bean and 0.63 ton/ha sunflower in his trial.

Rotation systems one and four included a fallow period of five months between soybean and the sequential crops. Maize and sunflower were planted in November 2016 and produced average yields of 7.06 ton/ha and 1.47 ton/ha respectively on the two trials. The yield of both crops were significantly higher on Danie's farm.

Table 8.4.13: Crop rotation system 1 (Soy bean – Maize)

Trial	Soy bean Nov 2015 – May 2016	Maize Nov 2016 - Jun 2017
Armand	0.94[a]	5.59[a]
Danie	0.94[a]	8.53[b]
Average	0.94	7.06
LSD:1.91; cv: 29.9%		

Armand

Danie

Table 8.4.14: Crop rotation system 3 (Soy bean – Wheat – Maize)

Trial	Soy bean Nov 2015 – May 2016	Wheat June 2016 – Dec 2016
Armand	0.66[a]	1.57[a]
Danie	1.03[a]	0.83[b]
Average	0.85	1.20
LSD: 0.54, cv: 32.8%		

Armand

Danie

Table 8.4.15: Crop rotation system 4 (Soy bean – Sunflower – Maize)

Trial	Soy bean Nov 2015 – May 2016	Sunflower Nov 2016 – June 2017
Armand	0.84^{a}	1.26^{a}
Danie	1.01^{a}	1.68^{b}
Average	0.93	1.47
LSD: 0.37, cv: 19.4%		

Armand

Danie

Table 8.4.16: Crop rotation system 2 (Soy bean – Wheat – Sunflower – Maize)

Trial	Soy bean Nov 2015 – May 2016	Wheat June 2016 – Dec 2016	Sunflower Jan 2017 – June 2017
Armand	0.79^{a}	1.30^{a}	*
Danie	1.03^{a}	0.76^{b}	0.63
Average	0.91	1.03	
LSD: 0.33, cv: 21.2%			

Armand

Danie

Table 8.4.17: Crop rotation system 6 (Soy bean – Wheat – Sugar bean – Maize)

Trial	Soy bean Nov 2015 – May 2016	Wheat June 2016 – Dec 2016	Sugar bean Jan 2017 – May 2017
Armand	1.00[a]	1.87[a]	*
Danie	0.93[a]	0.82[b]	0.28
Average	0.97	1.33	

LSD: 0.55, cv: 30.1%

Armand

Danie

Table 8.4.18: Crop rotation system 5 (Soy bean – Cover crop – Maize)

Trial	Soy bean Nov 2015 – May 2016	Cover crop (kg/ha) June 2016 – Sept 2016	Maize Nov 2016 - June 2017
Armand	0.86[a]	1.72[a]	5.47[a]
Danie	1.02[a]	2.10[a]	8.96[b]
Average	0.94	1.91	7.22

LSD: 1.20, 23.7%

Armand

Danie

Table 8.4.19 summarises the average crop yield per system obtained from both trials. Lower total rainfall until June 2016 had a huge impact on soil moisture and reflected negatively on yield –

especially in rotation systems two and six. Although systems one and four had a fallow period of five months, the soy bean stubble did not contribute much towards moisture preservation. According to the FAO, maize needs 500 mm to 800 mm water per total growing period in comparison to sunflower that needs 600 mm to 1000 mm per total growing period. An average good maize yield of 7.06 ton/ha was recorded in system one, while a lower average yield of 1.47 ton/ha was recorded for sunflower in system four, which indicated that the sunflower yield was reduced due to water availability. The average maize yield of 7.22 ton/ha obtained in system six after soy bean and a cover crop mix, compared favourable with the 7.06 ton/ha maize yield in system one.

Table 8.4.19: Summary of average crop yield per rotation system

Rotation system	Crop 1	Yield (ton/ha)	Crop 2	Yield (ton/ha)	Crop 3	Yield (ton/ha)
1	Soy bean	0.94	Maize	7.06	Soy bean	-
2	Soy bean	0.91	Wheat	1.03	Sunflower	*0.63
3	Soy bean	0.85	Wheat	1.20	Maize	-
4	Soy bean	0.93	Sunflower	1.47	Maize	-
5	Soy bean	0.94	Cover crop mix	**1.91	Maize	7.22
6	Soy bean	0.97	Wheat	1.33	Sugar bean	*0.28

*Only Danie planted these crops
** Dry plant mass yield

Planning for 2017/2018 season

The following problems need to be solved as soon as possible:

- Soil moisture probes in the trials were not fully functional and data were lost. VKB will contact the service provider to ensure that reliable data will be captured in future.
- The weather station is currently not working. VKB will follow up on the problem.

Maize will be planted in crop rotation systems two, three, four and six and the next sequenced crop in rotation systems one and five will be soy bean (Table 8.4.20).

Table 8.4.20: Trial plan

Replicate 1		**Replicate 4**
6 Maize		1 Soy bean
4 Maize		2 Maize
1 Soy bean		6 Maize
2 Maize		3 Maize
3 Maize		5 Soy bean
5 Soy bean		4 Maize
Replicate 2		**Replicate 3**
3 Maize		2 Maize

6 Maize		4 Maize
5 Soy bean		1 Soy bean
2 Maize		3 Maize
4 Maize		6 Maize
1 Soy bean		5 Soy bean

8.5. Agronomic field trial results in Ascent study area

Work period	October 2016 to September 2017

Lead partner	Local facilitators (Robert Steynberg, Jacques van Zyl, Suzette Smalberger (VKB))
Involved partners	Ascent study groups and other Innovation Platform (IP) partners Willem Killian, Lientjie Visser (ARC), Gerrie Trytsman (ARC), Paula Lourens (Vermi Solutions), Hendrik Smith (Grain SA)

Objectives	• Coordinate on-farm experimentation activities among all participating farmers • Ensure timely and correct implementation of relevant activities and treatments • Assist with the use of specialised implements for trial purposes • Promote synergy among farmer participants • Monitor selected indicators (through field form, sampling & visits) and report on project activities and progress related to farmer involvement.

Justification	On-farm experimentation involving farmers as 'researchers' are seen as central to research projects under the banner of the CA-Farmer Innovation Programme at Grain SA. This implies that trial treatments or replications are implemented on the farm by the respective farmer participants. A range of support measures are needed to ensure the success and quality of these farmer-led actions, including the engagement of relevant research and technical team members around these farmers. **A particular role and function identified by the project team is that of a local farmer facilitator, primarily assisting, guiding, calibrating and coordinating the participating farmers to implement the experimental designs (treatments) correctly.** This person also has to manage and move specific specialised implements (e.g. a no-till planter) between the farmers, allowing timely and correct use of it. The person selected should be locally based and should have an intimate knowledge of the local natural resources and stakeholders, especially the farmers. Expected result of this function is the elimination of undesirable variables and the increased quality of the trials and data.

Description of work	Prepare farmers and implement on-farm trials. Manage, maintain and move specialised implements to be used by the various farmers involved in the trials. Making sure that farmers understand the treatments and what is expected from them. Calibrate or train farmers on specific implements / practices where necessary. Conduct regular field/farm visits, monitor and coordinate relevant activities, assist with sampling of soil where necessary. Attend regular project meetings and assist with report writing.

Activities	1. Land preparation 2. Planting 3. Seasonal management 4. Monitoring and Sampling 5. Monthly meetings (project team) 6. Annual reference group meeting (advisory committee) 7. Annual report and admin

	8. Participate in Awareness events

Risks	• Being a dryland experiment, low and erratic rainfall may compromise crop yields; • Wild animals and birds may jeopardise crop performance and yields; • Instrumental and logistical failure can result in incomplete activities and results

ACTIVITIES AND DELIVERABLES

Activities	Deliverables
7. Land preparation	Assist farmers to lay out their trial plots Prepare (calibrate and train) farmers on the trial treatments Make sure land preparation (e.g. weeding) is done according to specifications Make sure the correct type and quantity of production inputs are ready and used
8. Planting	Prepare planter for planting Move planter between farmers for timely planting, where necessary Make sure farmers plant according to standard treatment specifications
9. Seasonal management	Assist farmers in weeding and pest/disease management
10. Monitoring and Sampling (Done with activity 3 above)	Assist farmers to complete field forms Assist to collect soil samples Monitor the farmer-led actions
11. Monthly meetings (project team) & Training	Participate in monthly forum meetings, discussing problems and possible solutions to that.
12. Annual reference group meeting (advisory committee)	Report progress and findings to advisory committee; Discussion and evaluation of data. Learning from each other.
13. Annual report and admin	Written report covering trial implementation, results and progress.
14. Participate in Awareness events	Trial visits with stakeholders; participate in awareness events, such as information day and/or cross-visits

DELIVERABLES, PROGRESS AND RESULTS ACHIEVED PER ACTIVITY

Activities *(as specified in Work Package or project proposal)*	**Deliverables or Milestones** *(as specified in Work Package or project proposal)*	**Progress and Results achieved;** and/or **Problems and Milestones <u>not</u> achieved** (in report period)
1. Planning of trials.	Farmer participation in meetings.	Reporting and planning meetings were held at Ascent on 16 August 2016 where farmer participants were confirmed.
2. Land preparation and planting of trials.	Trials were planted as planned during October-November 2016 period.	Assistance was given with the planting of trials where possible. Trials had established very satisfactory due to good rains.
3. Seasonal management and monitoring.	* Some measurements were made such as leaf chemical analysis of a fertilizer trial and soil water contents of some soils that were tilled differently. * Yields and yield components will be measured after harvesting. * Soil probe data are monitored on a continuous basis.	Proper reporting follows in the technical annual reports below. * A trial inspection and participation in a video recording was done on 6 December 2016. * Trials were visited by VKB Agricultural Development personell to create awareness of CA farming.
4. Awareness events.	Create awareness of CA farming practices through events and publications.	* A popular article titled "CA Research in the North Eastern Freestate" was written and submitted in February 2017 to SA Grain for plublication. * A CA farmers' day was organised on 24 August 2017.
5. Statistically analyse and report the results	Annual report Reporting as required and popular article once enough results have been acquired	Trial data was analysed and reported at a Studygroup meeting – 25 August 2017 and included in the annual report (see technical annual reports below)

A. MAIZE TRIALS

GENERAL PROCEDURES

Plant population strip trials were planted and each co-worker used his own farming equipment and followed his own standard practices regarding fertilization, cultivar selection, etc. The requirement for plant population treatments were to plant at least five treatments with plant populations ranging from 30 000 plants/ha to 100 000 plants/ha.

Three fertilizer pilot trials were done as well as a winter cover crop strip trial. Specific experimental details will be supplied below.

The trials are replicated over years which mean that proper statistical analysis will only be possible after another year. In the mean time three replicates were harvested per strip so that analysis of variance could be done although that is not entirely acceptable.

Plant populations were determined prior to harvesting. Sub plots totalling 10m row lengths were used and heads were counted and removed to be threshed with a small scale threshing machine. Moisture percentages were determined to present yield data on a 12.5% moisture basis.

The following co-workers took part in the experimentation:

Trial 1: I Dreyer (Skulpspruit)

Planted no till following a winter cover crop.
Row width: 0.76m
Fertilization: 130 N; 20 P; 10 K (kg/ha) mixed with gypsum and "green granules"
Cultivar: DKC 78 87
Planting date: 26 Oct. 2016
Harvesting date: 4 May 2017
Treatments:
Plant populations - 30k, 45k, 50k, 60k, 80k, 100k per ha

Trial 2: I Dreyer (Waterstroom

Planted no till following maize
Row width: 0.76m
Fertilization: 130 N; 20 P; 10 K (kg/ha) mixed with gypsum and "green granules"
Cultivar: DKC 74 74
Planting date: 3 Nov. 2016
Harvesting date: 18 May 2017
Treatments:
Plant populations - 30k, 40k, 60k, 80k, 100k per ha

Trial 3: I Dreyer (Vrede)

Planted no till following a winter cover crop.
Row width: 0.76m
Fertilization: 130 N; 20 P; 10 K (kg/ha) mixed with gypsum and "green granules"
Cultivar: DKC 71 44
Planting date: 10 Nov. 2016

Harvesting date: 17 May 2017

Treatments:

Plant populations - 30k, 45k, 50k, 60k, 80k, 100k per ha

Trial 4: JJJ van Rooyen

Planted conventionally.

Row width: 0.91m

Fertilization: 120 N; 30 P; 18 K (kg/ha)

Cultivar: 31 N 05

Planting date: 24 Oct. 2016

Harvesting date: 15 May 2017

Treatments:

Plant populations - 40k, 50k, 60k, 80k, 100k per ha

Trial 5: P Zietsman

Planted strip till.

Row width: 0.76m

Fertilization: 149 N; 27 P; 19 K (kg/ha)

Cultivar: DKC 37 92

Planting date: 4 Nov. 2016

Harvesting date: 15 May 2017

Treatments:

Plant populations - 20k, 40k, 60k, 80k, 100k per ha

Additional –

60k & 80k with extra 20kg/ha N and 6kg/ha P

100k with extra 30 N and 10 P

Trial 6: C Cronje

Planted strip till.

Row width: 0.76m

Fertilization: 130 N; 30 P; 20 K (kg/ha)

Cultivar: DKC 37 92

Planting date: 26 Oct. 2016

Harvesting date: 12 May 2017

Treatments:

Plant populations - 20k, 40k, 50k, 60k, 80k, 100k per ha

Additional –

100k with extra 200 N

Trial 7: D Portwig

Planted conventionally.

Row width: 0.91m

Fertilization: 100 N; 15 P; 10 K (kg/ha)

Cultivar: DKC 78 45

Planting date: 1 Dec. 2016

Harvesting date: 10 May 2017

Treatments:

Plant populations - 30k, 40k, 60k, 80k, 100k per ha

Trial 8: I Dreyer (Skulpspruit)

Planted no till following a winter cover crop.
Row width: 0.76m
Cultivar: DKC 78 87
Planting date: 26 Oct. 2016
Harvesting date: 4 May 2017

Treatments:

Fertilizer level - 0; 88; 117; 217; 265; 402; 617 kg/ha 3:2:1(25) mixed with gypsum and "green granules"

Trial 9: I Dreyer (Waterstroom)

Planted no till following maize
Row width: 0.76m
Fertilization: 60 N; 20 P; 10 K (kg/ha) mixed with gypsum and "green granules"
Cultivar: DKC 74 74
Planting date: 1 Nov. 2016
Harvesting date: 4 May 2017

Treatments:

Fertilizer level - 0; 50; 100; 150; 200; 250kg/ha LAN

Trial 10: I Dreyer (Genoeg)

Planted no till following maize
Row width: 0.76m
Fertilization: 60 N; 20 P; 10 K (kg/ha) mixed with gypsum and "green granules"
Cultivar: DKC 74 74
Planting date: 1 Nov. 2016
Harvesting date: 4 May 2017

Treatments:

Fertilizer level - 0; 100; 150; 200; 250kg/ha LAN

Trial 11: I Dreyer (Vrede).

Planted no till following a winter cover crop.
Row width: 0.76m
Fertilization: 130 N; 20 P; 10 K (kg/ha) mixed with gypsum and "green granules"
Cultivar: DKC 71 44
Planting date: 7 Nov. 2016
Harvesting date: 17 May 2017

Treatments:

WCC – winter cover crop
NWCC - control

TRIAL RESULTS FOR THE 2016/2017 SEASON

Rainfall

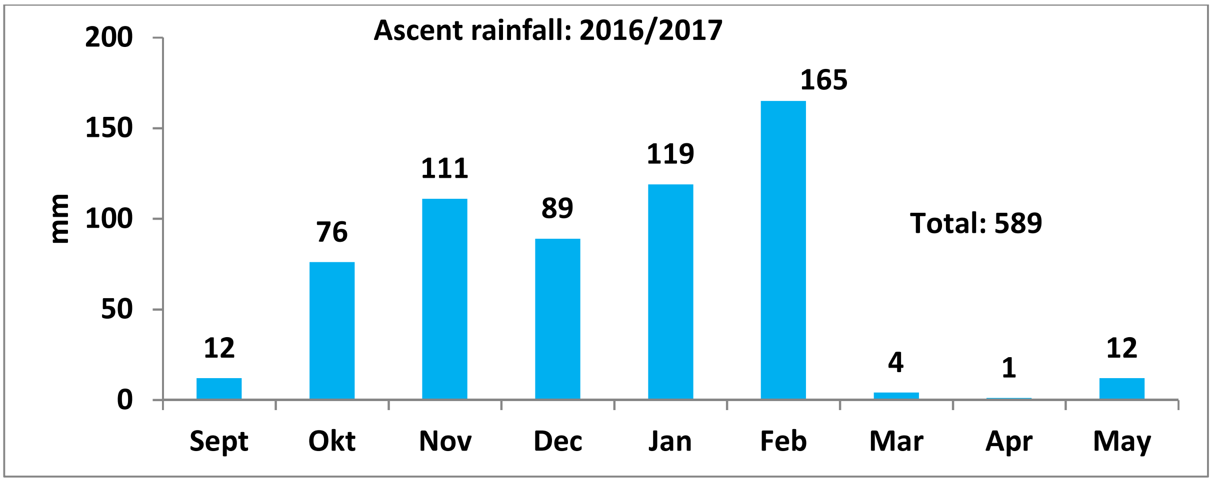


Figure 8.5.1. Monthly rainfall data for Ascent 2016/2016.

Figure 8.5.1 shows good rainfall for the season. The season started with the October rains that fell in a period of three days just before planting commenced during the last week of the month. Thereafter the rainfall was distributed quite well except for February when a three week dry period occurred that stressed crops just before excessive rains fell during the last week of this month. The abrupt discontinuance of rain at the end of February was abnormal and late planted crops were generally harmed by it.

Effect of winter cover crop on soil water conservation

Figure 8.5.2 shows how various treatments influenced the water content of soils. The pre-summer rain observations were made three weeks before the rainy season started. It can therefore be assumed that the treatments with winter cover crops had dried out a little more towards the end. These treatments were thus almost as dry as the treatment with conventional tillage. The no-till control treatments were significantly wetter even after September and most of October had been dry. It can be seen from Figure 8.5.2 that the first rain wetted all the soils properly (soil depth was 60 cm). All differences were thus wiped-out even before planting started.

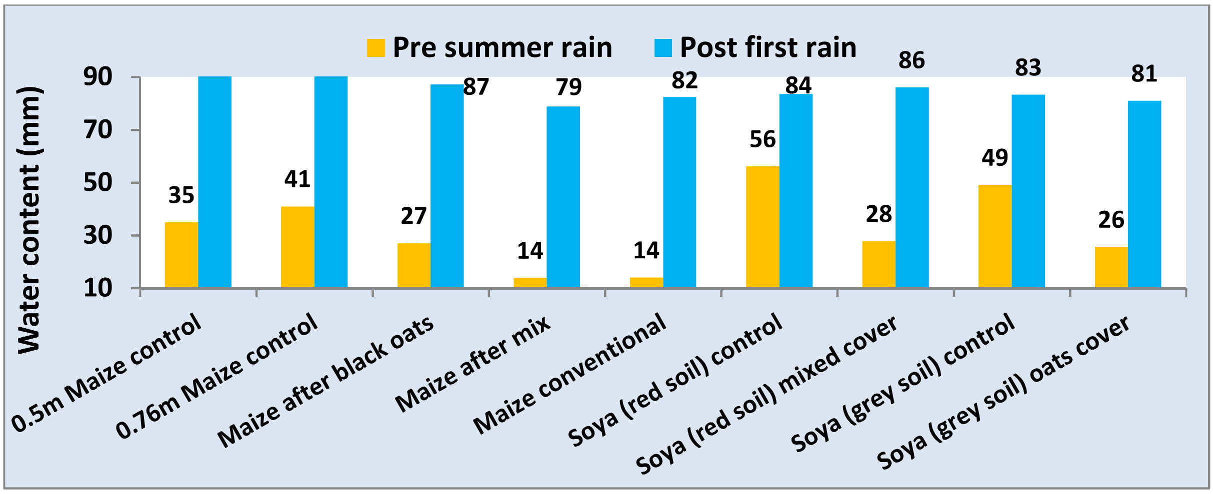


Figure 8.5.2. Soil water content for different tillage treatments prior and after the summer rains began to fall in October 2016.

Root growth in conservation agriculture

It was shown in the previous year that water infiltration rates were much better under CA conditions than under conventional tillage (CT). It was assumed that one of the reasons would be old root channels that enabled increased infiltration rates. The results also suggested that soil compaction was not a problem under the CA conditions. This year profile holes were dug to examine rooting patterns from which one could also infer whether old root channels might play a role in terms of alleviating the effects of soil compaction. Photo 8.5.1 shows a concentration of roots directly under the plant row. This is coincidentally where the previous year's soya bean row had been. A second concentration of roots was observed in the middle between rows where the winter cover crop row had been.

Photo 8.5.1. A concentration of roots were observed directly beneath the plant row (photo on the left) and a second concentration were observed midway between rows where a winter cover crop row had been (photo on the right).

Maize plant population trials: Yield and ear development

Although a positive relationship between yield and plant population was observed in Trial 1 (Figure 3a) it seems that yield levelled off at plant populations higher than roughly 50 000 plants/ha. Figure 3b shows that it was a multi eared cultivar that was used and that the ears per plant quickly declined with increases in plant population.

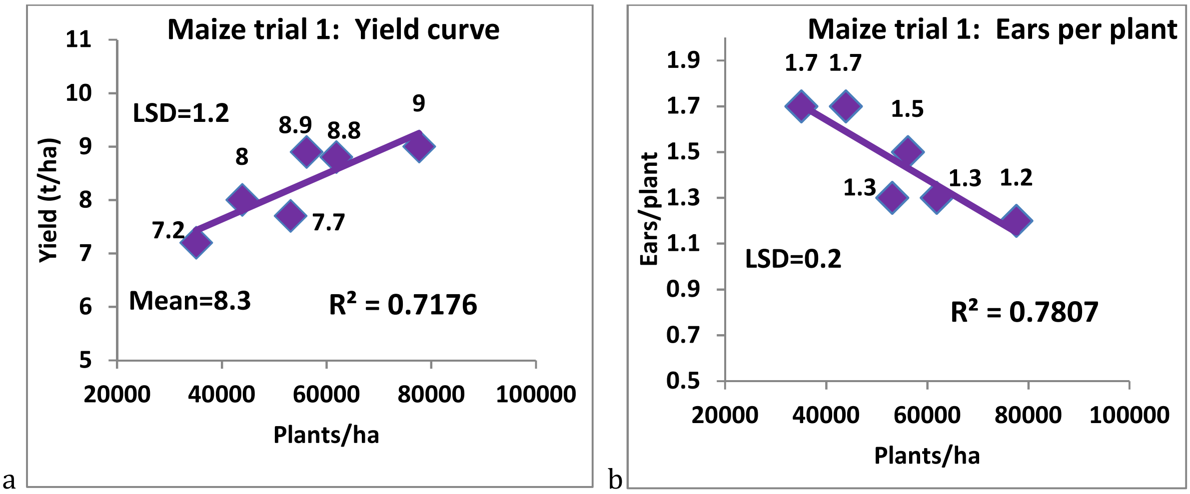


Figure 8.5.3. Maize trial 1: a) plant population/yield curve and b) plant population/ear number curve.

Figure 8.5.4a showed no yield effects for increased plant populations in Trial 2. A mainly single eared cultivar was used according to Figure 4b.

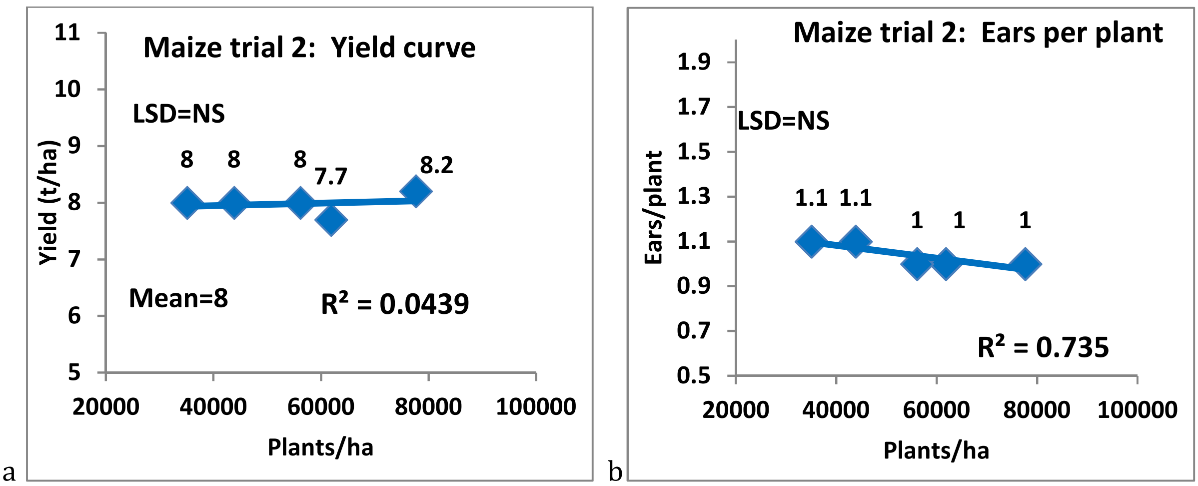


Figure 8.5.4. Maize trial 2: a) plant population/yield curve and b) plant population/ear number curve.

The low R^2-value for Trial 8.5.3 also suggests a lack of correlation between yield and plant population (Figure 8.5.5a). A multi eared cultivar was used for this trial (Figure 8.5.5b).

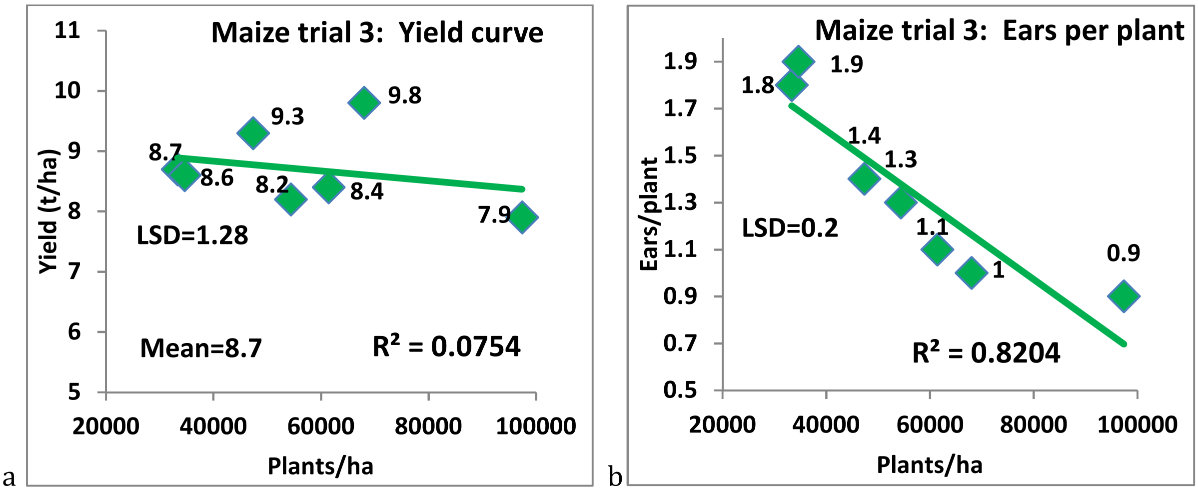


Figure 8.5.5. Maize trial 3: a) plant population/yield curve and b) plant population/ear number curve.

A very low R^2-value was also observed for Trial 4 (Figure 8.5.6a). There are some treatments that differed significantly from others but the trend was not clear. Figure 8.5.6b suggests that it was a mainly single eared cultivar.

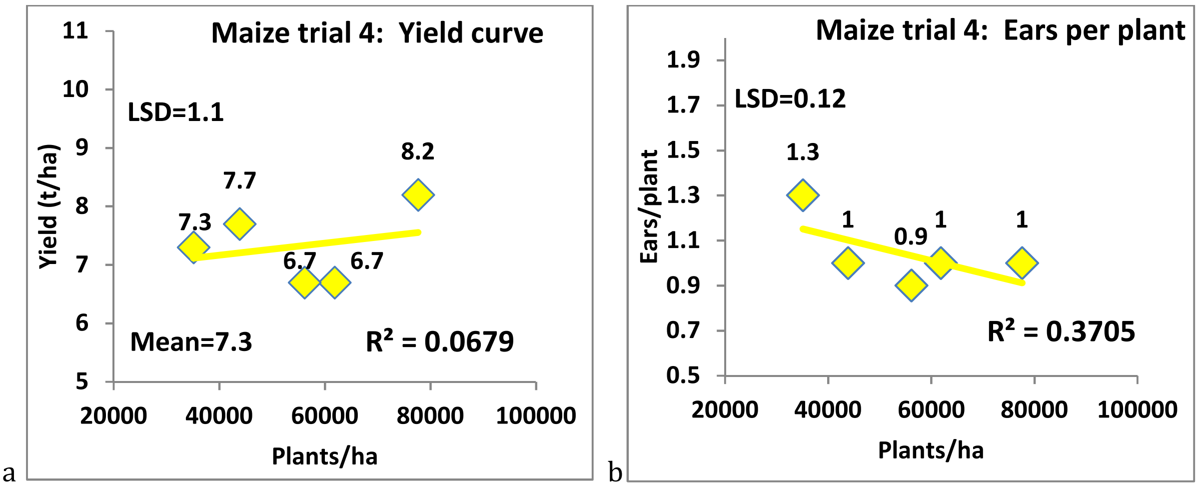
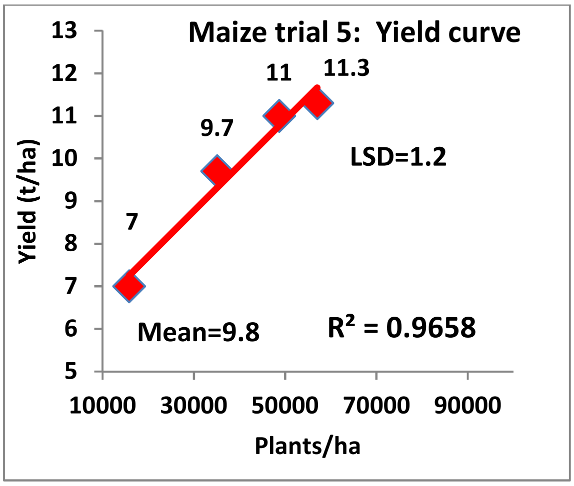


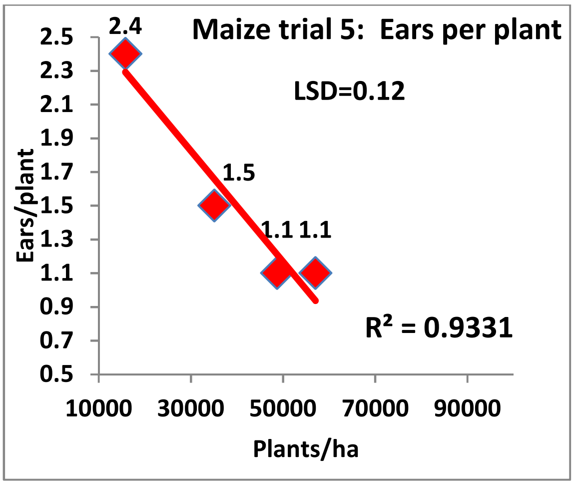
Figure 8.5.6. Maize trial 4: a) plant population/yield curve and b) plant population/ear number curve.

Trial 5 produced very high yields and it correlated very positively to plant population (Figure 8.5.7a). There was however, a suggestion that yields levelled off at plant populations of 50 000 plants/ha and higher. A multi eared cultivar was used which apparently was very sensitive to variable plant populations (Figure 8.5.7b).

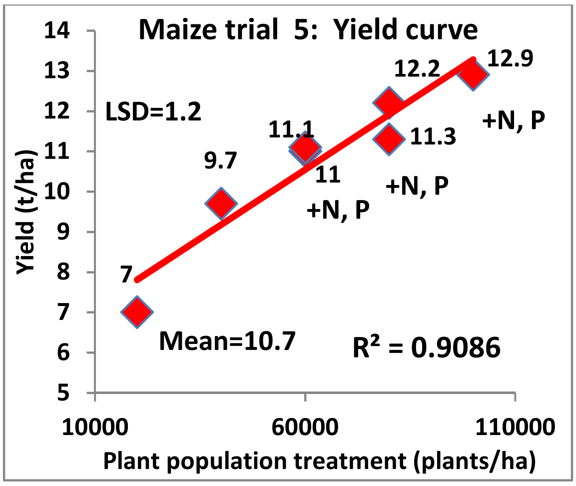
Figure 7c shows how the yield/plant population correlation was altered by increased fertilizer application. Yields did not level off at plant populations of more than 60 000 plants/ha when more fertilizer was applied.



a



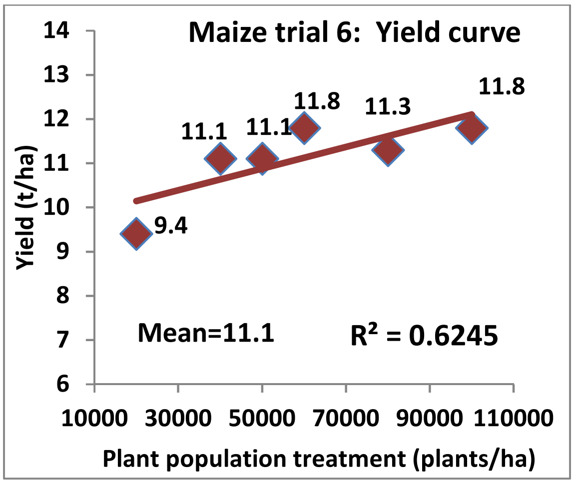
b



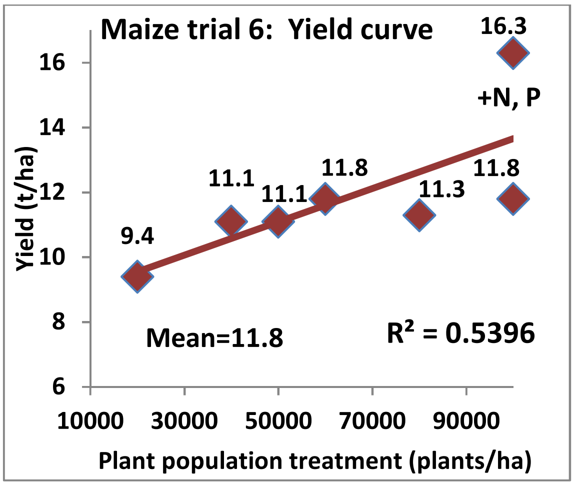
c

Figure 8.5.7. Maize trial 5: a) plant population/yield curve and b) plant population/ear number curve and c) plant population yield curve with some treatments having received increased fertilizer rates.

Trial 6 also showed a positive correlation between plant population and yield (Figure 8.5.8a) although yields started to level off at 60 000 plants/ha. The same cultivar from Trial 5 was used in this trial. The 100 000 plants/ha treatment was replicated with the addition of more fertilizer and the positive effect thereof can be seen in Figure 8.5.8b.



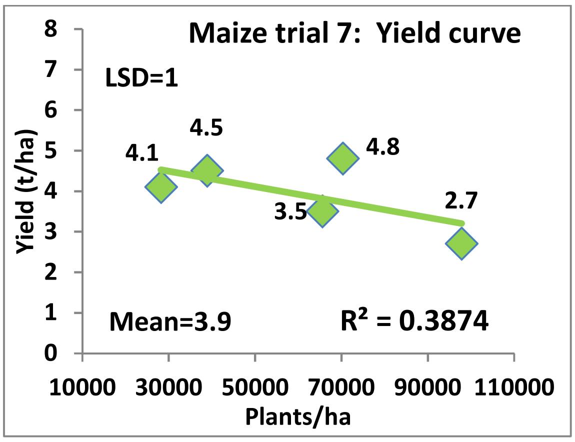
a



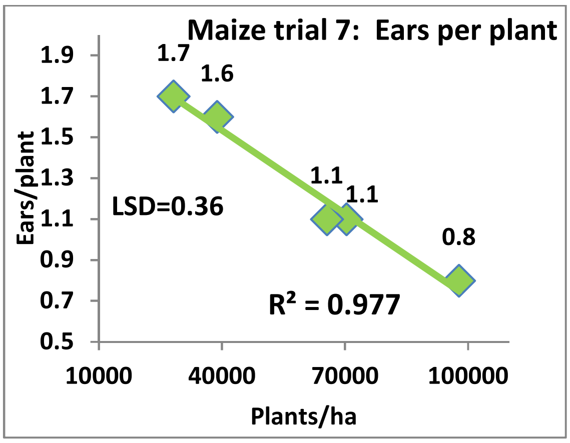
b

Figure 8.5.8. Maize trial 6: a) plant population/yield curve and b) plant population yield curve with a 100 000 plants/ha treatment having received increased fertilizer rates.

Trial 7 was replanted because of poor emergence after the first attempt. The consequence was a late planting date of December 1 which resulted in a low mean yield of 3.9 t/ha. Figure 8.5.9a shows a poor plant population trend but with the 100 000 plants/ha treatment yielding the lowest. Rainfall distribution and the late planting date were to blame for the low yields. As was shown previously, the rainfall for the season ended abruptly at the end of February and this crop still needed rain badly during March. It once again showed how the effect of sufficient rainfall can override other yield determining factors. Figure 8.5.9b shows that a multi eared cultivar was used.



a



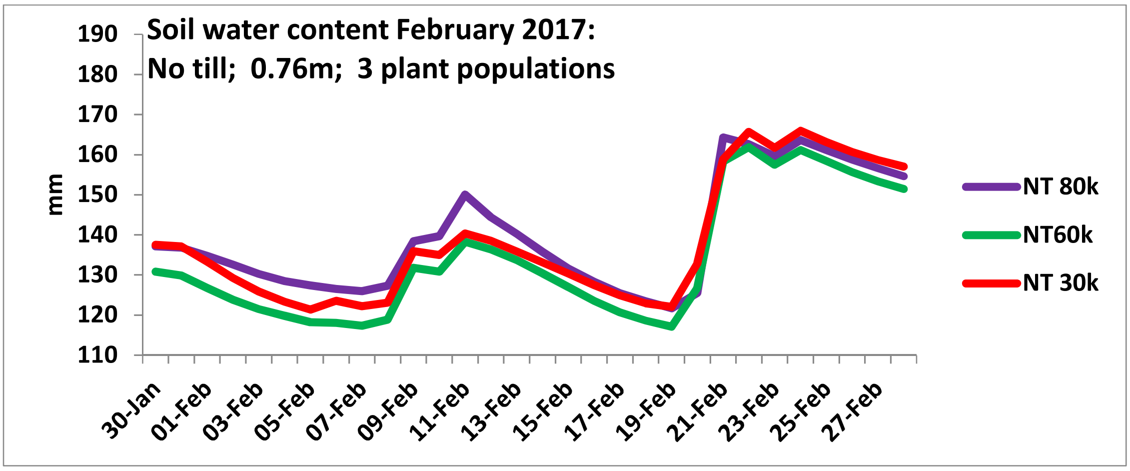
b

Figure 8.5.9. Maize trial 7: a) plant population/yield curve and b) plant population/ear number curve.

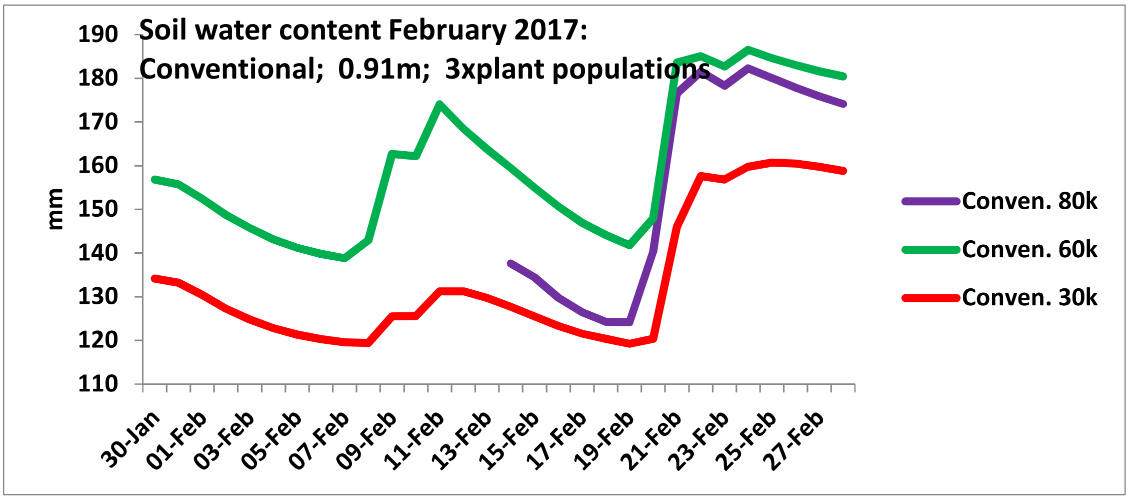
Soil water extraction

Figure 8.5.10a shows no significant differences in soil water content for February between three plant population treatments under no-till conditions. The numbers reflect total water content to a depth of 80 cm. The high values suggest that some refinement need to be done to the calibration.

Some of the data went missing for the 80 000 plants/ha treatment under CT (Figure 8.5.10b). It can be seen that the 30 000 plants/ha treatment started drier and also finished the month drier than the other treatments. It would only make sense if this treatment lost a little more water due to evaporation. The wider rows of 0.91 m might have played a role as the same effect was not noted in the narrower rows of 0.76 m.



a

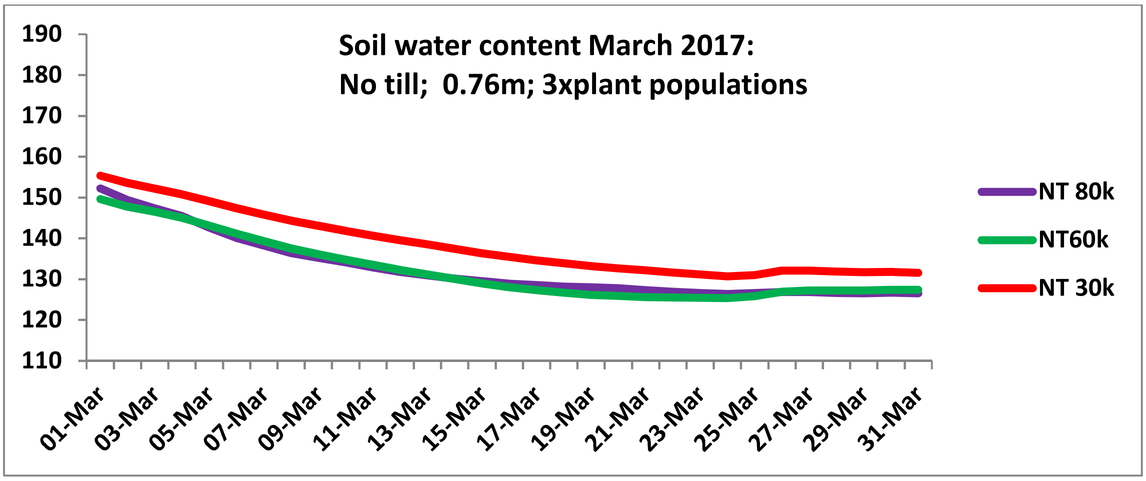


b

Figure 8.5.10. Total soil water for February 2017 measured with a soil probe for a) three plant populations under no till conditions and b) three plant populations under conventional tillage conditions.

Figure 8.5.11 illustrates the soil water probe data for March. The treatment differences remained more or less the same than those that were observed for February. The soil for the no till treatments ended drier than the other treatments except for the 30 000 plants/ha treatment.

a



b

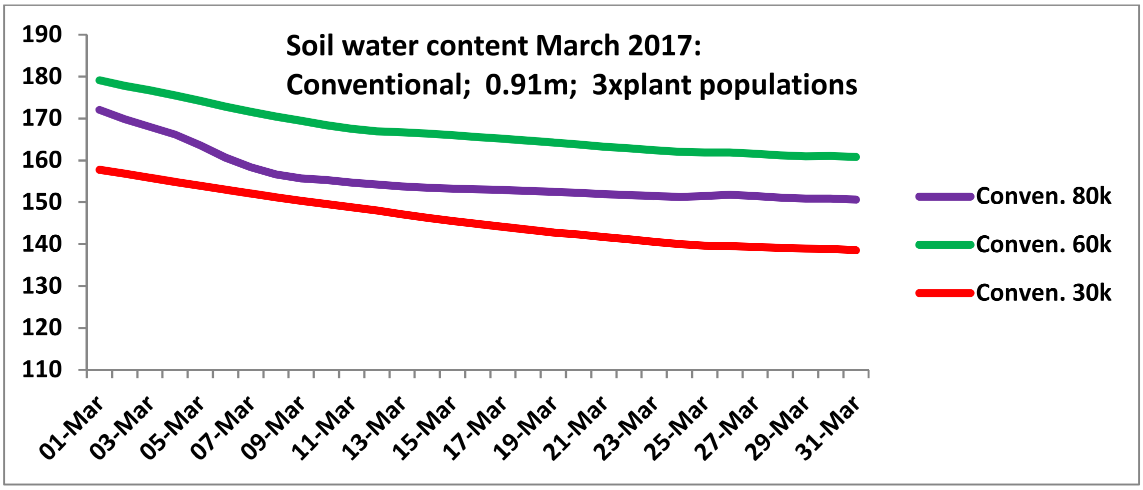


Figure 8.5.11. Total soil water for March 2017 measured with a soil probe for a) three plant populations under no till conditions and b) three plant populations under conventional tillage conditions.

The peaks in Figure 8.5.10 show how soil water increased after rainfall. Calculations were made to determine soil water differences between peaks and troughs. Figure 8.5.12 shows these determinations for three periods. The first two periods (Figure 8.5.12a and 8.5.12b) were very short but indicated interaction between plant population and tillage or row width. At the lowest plant population the no-till narrower rows used more water than the conventionally tilled wide rows. An opposite trend was noted at higher plant populations. The longest period of a month at the end of the season (Figure 8.5.12c) showed that the no till treatments used considerably more water for all plant populations than the conventionally tilled treatments.

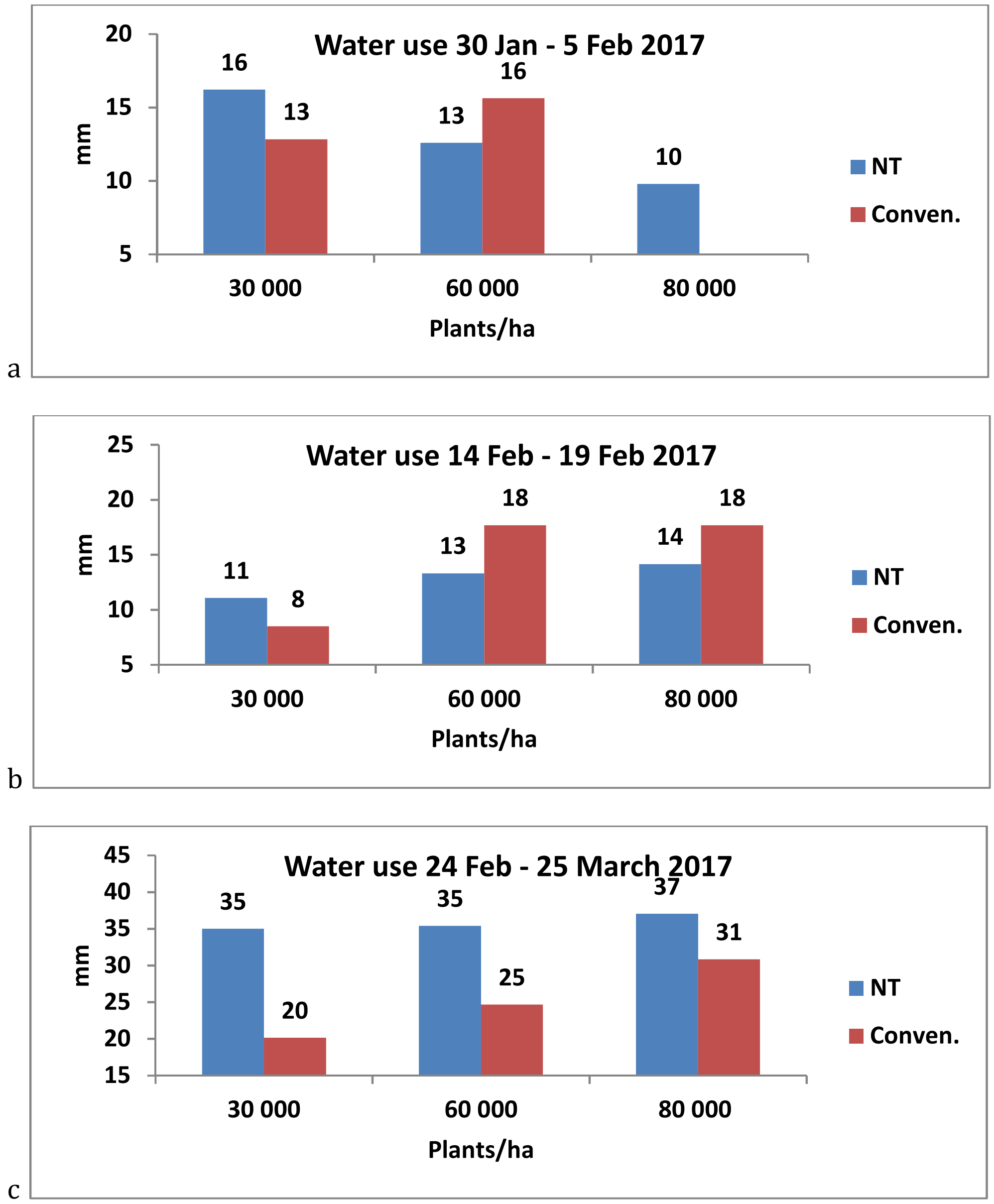


Figure 8.5.12. Water use for three different periods after rain had fallen on a plant population experiment under no tilled (row width 0.76m) and conventionally tilled (row width 0.91m) conditions.

CA and fertilization: Yield

Photo 8.5.2 shows what a strip with zero fertilizer looked like shortly after emergence. The yellowing did not last long and the only effect that remained was delayed flowering as can be seen in Photo 8.5.3. Figure 8.5.13a shows how little the yields varied over fertilizer levels ranging from zero fertilization to 617 kg/ha 3:2:1(25). The soya beans of the previous season and the winter cover crops which followed apparently had a positive influence on soil fertility. Figure 8.5.13a also shows the yield of a control treatment representative of the normal commercial fertilization rate for the farm where the Nitrogen applied reached a rate of 130 kg/ha. No additional advantage was observed for this treatment.

Photo 8.5.2. The zero fertilizer strip with yellowing of plants can clearly be seen on the left. These symptoms disappeared after a while as can be seen on the right.

Photo 8.5.3. The only indication of something different in the zero fertilizer treatment was the delayed flowering of almost one week (left). No visible differences were seen between treatments after flowering was completed (right).

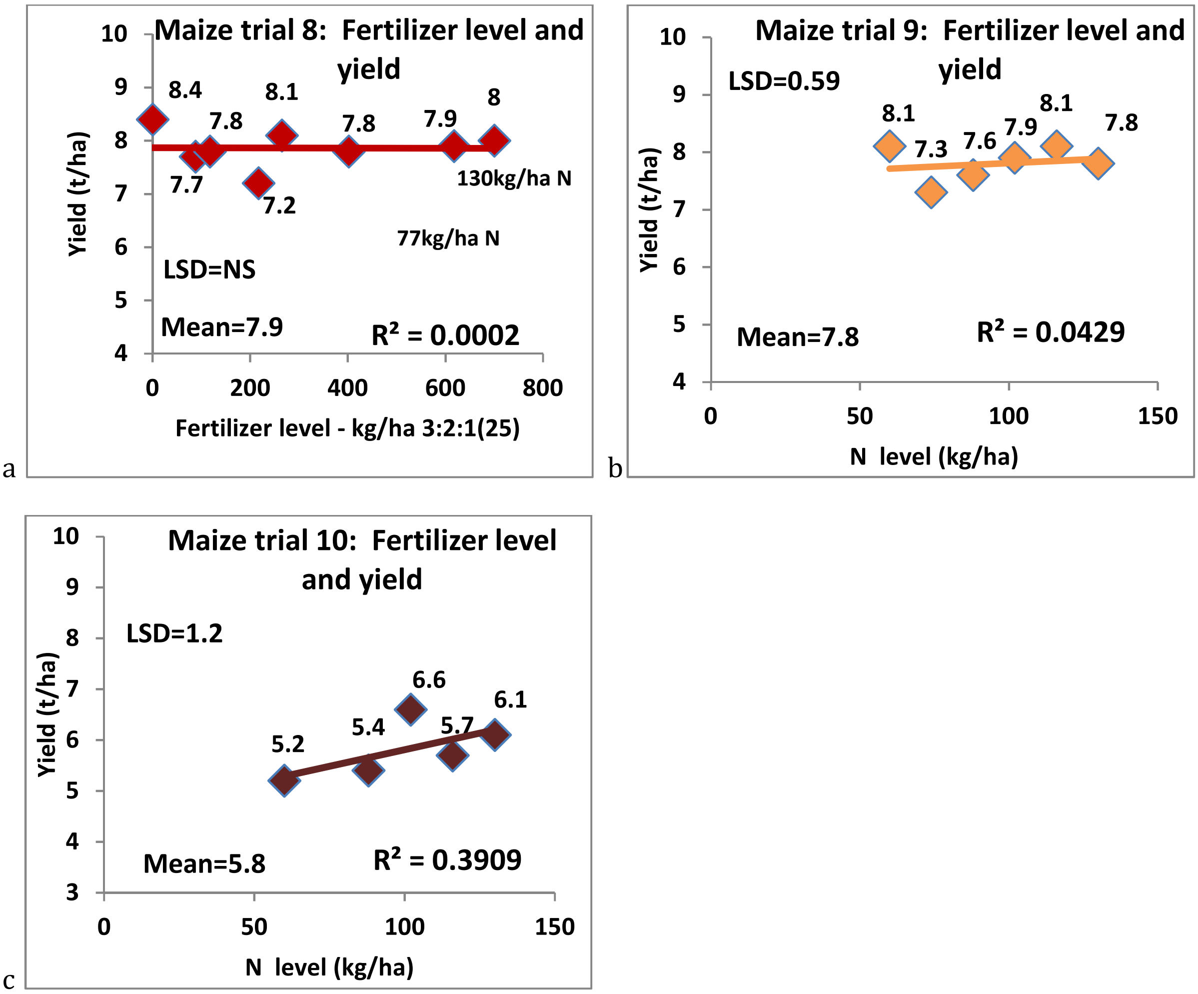


Figure 8.5.13. Maize trials 8 -10: Effect of fertilization levels on maize yield produced under no till conditions.

The treatments of Trials 9 and 10 consisted of different levels of LAN top dressing. The lowest fertilizer treatment thus consisted of a treatment of 60 kg/ha N which was applied before and with planting. The low R^2-value in Figure 8.5.13b indicates that there was no N-fertilization top dressing effect. Yields nearing 8 t/ha were achieved which is very good for dry land conditions.

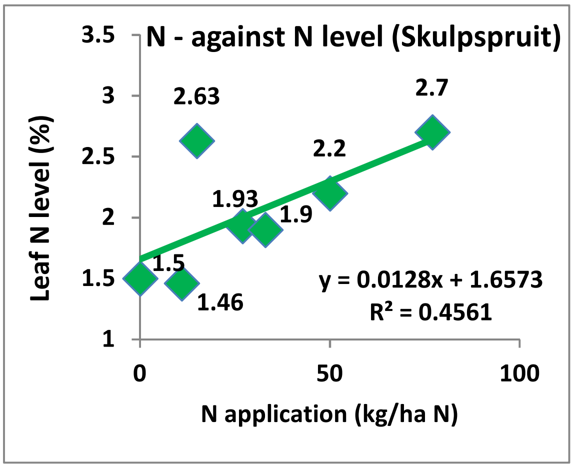
The results of Trial 10 differed somewhat. It can be seen in Figure 8.5.13c that yields increased with increased N fertilization levels. It seems that 100 kg/ha N was enough to achieve the highest yield. The mean yield of this trial was below 6 t/ha and the reaction to fertilization indicates that yield was limited by low soil fertility levels and not by other factors such as plant population or water availability.

CA and fertilization: Leaf analysis

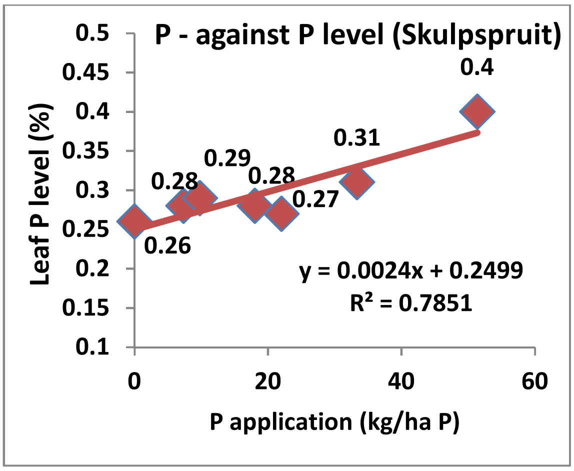
Figure 8.5.14a and 8.5.14b show positive correlations for N- and P-leaf analysis against N- and P-fertilization levels respectively. In terms of N content it was only the 2.63% and 2.7% values that could have been classified as sufficient. The other values were either low or very low according to present norms. In the case of P content, the 0.4% level could be classified as high. The rest can be classified as good to very good.

All the K values can be classified as very low and it seemed to decrease with increased K fertilization level which doesn't make sense (Figure 8.5.14c). One has to take into account that Gypsum was added to the fertilizer mixture that was applied with planting. Thus, Ca increased with increased fertilizer rate and Ca antagonism could have occurred to explain the decrease of leaf K content with increased fertilization rates.

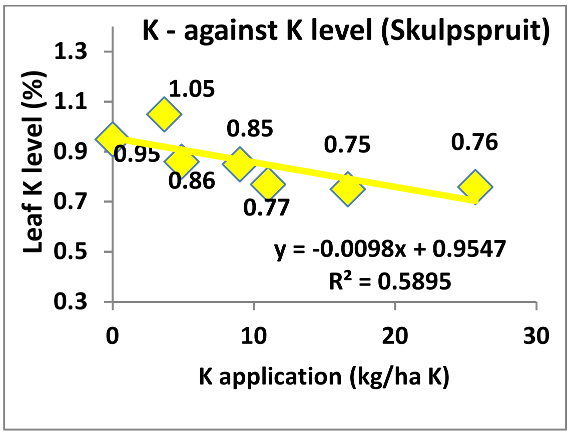
Figure 8.5.13a showed no yield effects which means that leaf analysis values did not correlate to observed yields.



a



b



c

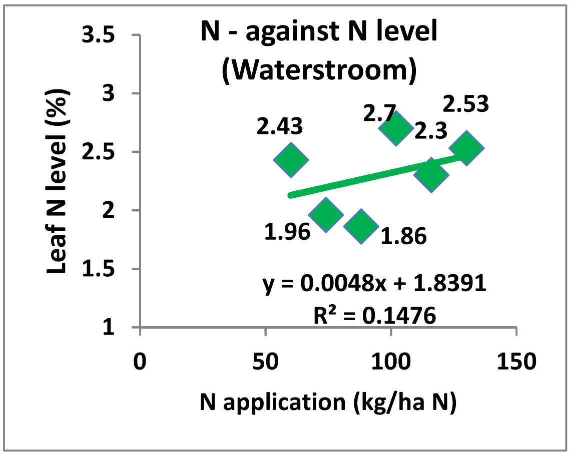
Figure 8.5.14. Maize leaf N-, P- and K-contents plotted against the respective N-, P- and K-levels applied with varying rates of a 3:2:1(25) mixture.

Figure 8.5.15 shows leaf analysis values for Trial 9 where only the top dressing levels for N were varied. Since differences were observed the values were correlated to N treatment levels to try and make sense. The N contents were not correlated very well with N fertilization level (Figure 15a). All values could be classified as good except for the two lowest values which were classified respectively as low and very low.

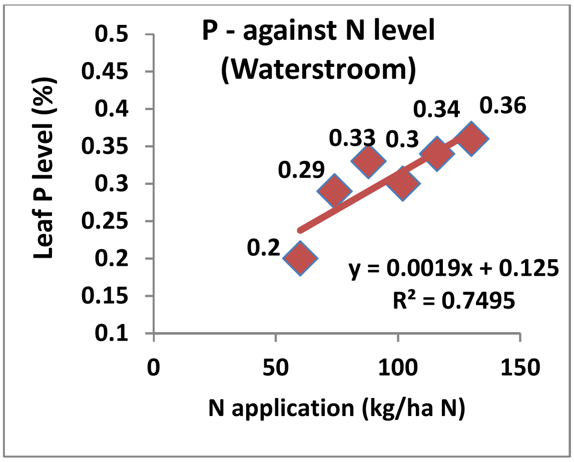
P values were positively correlated to N fertilization level suggesting a synergistic relationship to nitrogen (Figure 8.5.15b). The lowest value was classified as low but the rest were classified as good to high.

K values were not correlated to N level and all these values were classified as very low (Figure 8.5.15c).

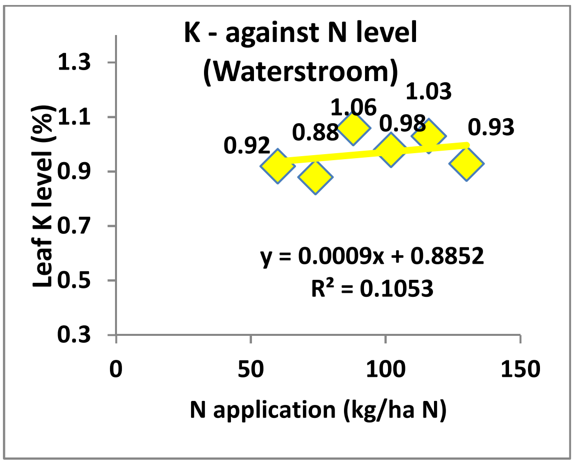
Leaf analysis values did not suggest that minimal yield differences between treatments would occur as was shown in Figure 8.5.13b.



a



b



c

Figure 8.5.15. Maize leaf contents for N, P and K plotted agains varying N fertilization levels.

Winter cover crop: Yield

Figure 8.5.16 shows no significant differences between a winter cover crop treatment and the control treatment. It is a confirmation of results that were obtained in the previous year when lower rainfall was experienced. The results pave the way for including winter cover crops for their many positive effects in conservation farming systems without the fear of yield limiting effects for the next year's crop.

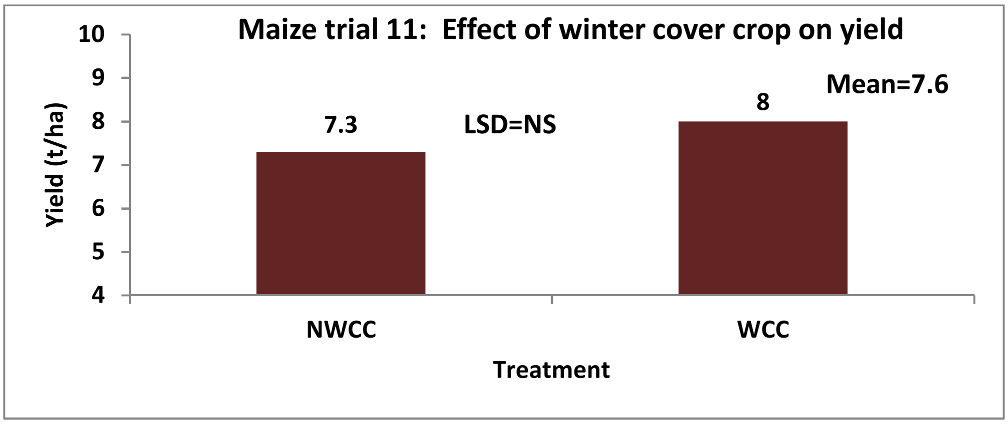


Figure 16. Maize trial 11: Effect of a winter cover crop on maize yield.

CONCLUSIONS AND RECCOMENDATIONS

The trials had been replicated for the second year but there are still not enough replicates to examine the row- and tillage effects with the help of statistical procedures (between farmers). A late planted trial yielded very poorly because of late season drought which underscored the importance and overriding effect of water and rainfall distribution. It also showed how important it is to do long term research to try and filter the effects of climate.

Maize plant population

Plant populations of 20 000 plants/ha seems to limit yields under rainfall conditions when like this year, the total rainfall approached 600 mm for the season. Yields increased with increased plant populations to a level of 40 000 to 50 000 plants/ha after which yields levelled off at between 8 to 9t/ha. It seemed that soil fertility and/or fertilization level had to be increased before yields could be increased by higher plant populations. It was demonstrated that yield increases can be expected up to 100 000 plants/ha if other yield limiting hindrances such as plant nutrition and/or water can be taken care of. Economic considerations will become more important at these high plant populations and fertilizer levels. Genetic yield potential will eventually also be a factor to be considered but this year's results did not suggest that it was the next yield limiting factor.

Maize fertilization

The pilot fertilizer trials did not show increased yields resulting from increased fertilizer levels where mean yields of 8t/ha were obtained. These trials were planted at plant populations of 45 000 plants/ha which might have been the limiting factor. It seems that yields higher than 8t/ha will need higher plant populations as well as higher fertilizer levels. When mean yields were lower than 8t/ha there were fertilizer effects in terms of increased yields. It seems that current mean yields of about 8t/ha for a normal rainfall year are limited by plant population and when lower yields are obtained the limiting factor is fertilization. Higher plant populations and fertilizer levels should increase yields but at these higher levels it becomes increasingly important to also investigate the long terms sustainability which should include the risk for subsoil acidification.

Winter cover crops in CA

No negative yield effects were measured on maize which was planted after a winter cover crop. It was a good rainfall year but the same result was found for the previous year which was a dry year. It seems that the effective usage of rain during the year is more important than the moisture that can be conserved from one season to the next. One should take into account that the soil under consideration is relatively shallow. Thus, it cannot conserve much water on the one hand and on the other hand it doesn't need much water at the beginning of the season to become fully wet. The effect of rainfall distribution must still be investigated because it is known that a dry period during a sensitive stage of the season influences yield more than total rainfall.

At this stage it can be recommended that winter cover crops can be considered for the known benefits to the soil biology and long term conservation effects thereof.

<u>SOYA BEAN TRIALS</u>

GENERAL PROCEDURES

Detailed information will be given on the results pages whilst general procedures will be presented here.

The co-workers that planted trials were as follows:

<u>I Dreyer: Trial 1</u>

A 4x4x2 factorial experiment (maturity class x plant population x row width) with 4 replicates was planted at Ascent, North of Vrede. A 10-row planter was used to plant rows of 0.76m width. Narrow rows of 0.38m were created by double planting with the wide row planter. Plants were thinned by hand to achieve variable plant populations. Hand thinning was chosen as a technique to increase randomization and to manipulate plant populations better than what is normally achieved when using planter gears to vary plant density.

I Dreyer: Trial 2

The trial consisted of narrow rows that were planted with a 0.38m row width planter and 0.76m rows were planted with a different planter. Plantpopulations of the narrow rows were lower than those of the other rows. Three replicates were done.

I Dreyer: Trial 3

This trial was almost the same as Trial 2. The difference was the inclusion of a wide row treatment that was obtained by removing every second row of a narrow row planted plot. This wide row treatment had very low plant populations. Four replicates were done.

J van Dyk: Trial 4

A 4x4 factorial experiment (maturity class x plant population) with 3 replicates was planted at Memel/Vrede. The elevation above sea level of this area North of Vrede is generally 150m higher than the rest of VKB's production area. It is also almost 2º C cooler than the rest of VKB's area. A 12-row planter was used and planting density was varied by the use of the planter gears.

J van Dyk: Trial 5

Row widths of 0.6m and 0.3 were compared using a single cultivar. Four replicates were done.

J Nell: Trial 6

A 4x4x2 factorial experiment (maturity class x plant population x row width) with 4 replicates was planted at Memel/Vrede. This trial was planted on the same type of clay soil than the soil used for Trial 2. A late planting date was used as is shown on the results pages. A 6-row planter was used and double planting was done to achieve narrow rows. Thinning was done by hand in the narrow rows whereas the planter gears were used to vary plant population in the wide rows.

JJJ van Rooyen: Trial 7

A tillage trial was started by planting soya beans for the first year. An eight row planter was used and four replicates were used. The treatment combinations are outlined under the heading for specific procedures.

S Fourie: Trial 8

A plant population trial with a single cultivar and four replicates were planted with a ten row planter.

The following Sensako cultivars provided a range of maturity classes:

Cultivar SSS 4945 – Maturity class 4.5

Cultivar SSS 5449 - Maturity class 5

Cultivar SSS 6560 - Maturity class 6

The commercial cultivar of the specific farmer where the trial was done was included as a fourth cultivar.

The plots consisted of two 5m rows that were harvested by pulling up whole plants and transporting them in bags to a store for threshing. A small scale threshing machine was used and small samples were taken for determining moisture contents afterwards. Yields were compared on a 12,5% moisture content basis.

Harvesting dates differed according to the requirements of the different maturity classes. It was generally done about two weeks after physiological maturity had been reached for a specific maturity class.

Pod heights were determined prior to harvesting. A measurement was made after subjectively determining which plants were most representative of the treatment combination.

Pod numbers per plant were detemined during harvesting. Plants were pulled from the ground by hand and put in bundles of 10 to assist with determining the plant population. One of these bundles was selected and all the pods counted to determine the mean number of pods per plant.

Morphological development could only be monitored once a week. Crude differences could be demonstrated but finer differences would require finer measurements than what weekly observations could provide.

Specific experimental details were as follows:

Trial 1

Tillage practice: No Till

Fertilizer: 8kg/ha N; 16kg/ha P + gypsum + "green granules"

Planting date: 27 October 2016

Harvesting date: Differentially (two weeks after physiological maturity)

Treatments:

Plant population – 100k, 200k, 270k and 400k per ha

Row width – 0.38m en 0.76m

Maturity class – 4.5 (Cultivar SSS 4945)

- 4.6 (Cultivar LS 6146)
- 5 (Cultivar SSS 5449)
- 6 (Cultivar SSS 6560)

Trial 2

Tillage practice: No till

Fertilizer: 8kg/ha N; 16kg/ha P + gypsum + "green granules"

Cultivar: LS 6146 (maturity class 4.6)

Planting date: 3 November 2016

Harvesting date: 5 March 2016

Treatments:

Row width – 0.38m

- 0.76m

Trial 3

Tillage practice: No Till

Fertilizer: 8kg/ha N; 16kg/ha P + gips + "green granules"

Planting date: 3 November 2016

Cultivar: LS 6146 (maturity class 4.6)

Harvesting date: 5 March 2016

Treatments:

Row width – 0.38m

- 0.76m (1)
- 0.76m (2) planted with 0.38m planter and removing every second row

Trial 4

Tillage practice: No Till

Fertilizer applied: 9kg/ha N; 9kg/ha P; 18kg/ha K

Row width: 0.6m

Planting date: 26 October 2016

Harvesting date: Differentially (two weeks after physiological maturity)

Treatments:

Plant population – 200k, 300k, 400k en 500k per ha

Maturity class – 4.5 (Cultivar SSS 4945)

- 4.4 (Cultivar Patrys 100)
- 5 (Cultivar SSS 5449)
- 6 (Cultivar SSS 6560)

Trial 5

Tillage practice: No till

Cultivar: Maturity class 4.6 (LS 6146)

Fertilizer: 9kg/ha N; 9kg/ha P; 18kg/ha K

Planting date: 26 October 2016

Harvest date: 28 March 2017

Treatments:

Row width – 0.6m en 0.3m

Trial 6

Tillage practice: No Till

Fertilizer applied: 8kg/ha N; 12kg/ha P; 16kg/ha K

Planting date: 2 December 2016

Harvest date: Differentially (two weeks after physiological maturity)

Treatments:

Plant population – 200k, 300k, 400k, en 600k per ha

Row width – 0.445m en 0.91m

Maturity class – 4.5 (Cv. SSS 4945)

- 4.6 (Cv. LS 6146)
- 5 (Cv. SSS 5449)
- 6 (Cv. SSS 6560)

Trial 7

Fertilizer: 10kg/ha N; 20kg/ha P; 30kg/ha K

Cultivar: Maturity class 4.6 (LS 6146)

Planting date: 15 November 2016

Harvest date: 29 March 2017

Treatments: (initiating a tillage trial)

Tillage **–** Treatment 4. Conventional - Treatment 1, 3, 5 & 6 No till

- Treatment 2 – No till with a winter cover crop

Plant population

- Treatment 3; 280k
- Treatment 1: 320k
- Treatment 2, 4, 5, 6: 350k

Row width – Treatment 1-5: 0.91m

- Treatment 6: 0.455m

Trial 8

Tillage practice: Strip till

Cultivar: Maturity class 6.4 (LS 6164)

Fertilizer: None

Row width: 0.76m

Planting date: 1 November 2016

Harvest date: 10 April 2017

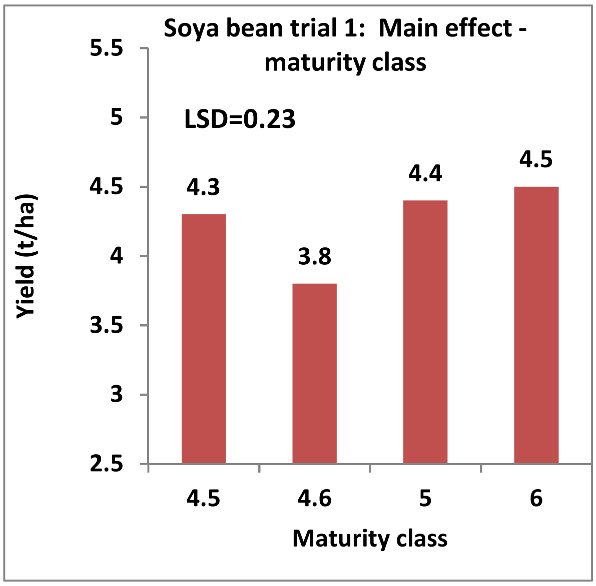
Treatments:

Sow density – 35kg, 45kg, 65kg, 85kg and 100kg/ha seed

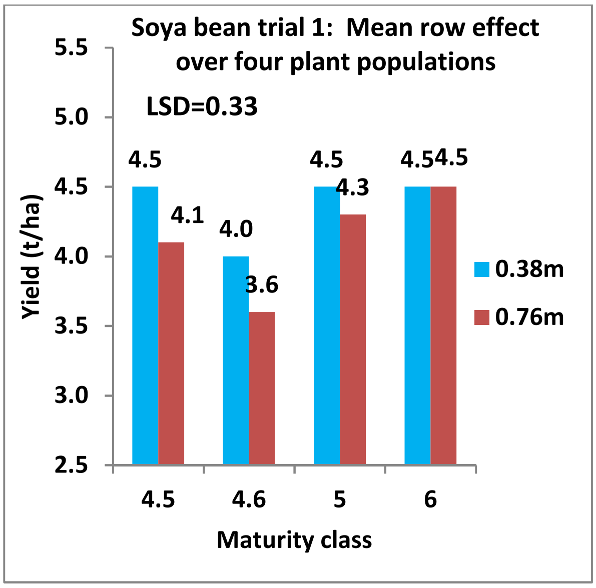
RESULTS

Yield - main effects for maturity classes

Only maturity classes 4.6 and 6 differed significantly from one another in terms of mean yields in Trial 1 (Figure 8.5.17a). There is however, a suggestion that the longer maturity classes tended to have the higher yield potential. This tendency is more noticeable in the wide rows (Figure 8.5.17b). It seems that narrow rows might help short maturity classes under early planted conditions to overcome the yield potential disadvantage that they might have relative to longer maturity classes.



a



b

Figure 8.5.17. Main effect for maturity class (a) and maturity class x row width interaction (b) for soya bean yield in Trial 1.

Trial 4 was planted early and the row widths of 0.6m resulted in very satisfactory yields (Figure 8.5.18). There were however, no real advantages for the longer maturity classes. There were water stress periods during the season and the last one was especially severe when the rain kept away from the beginning of March to the end of the season. It was the last dry period that kept the longer maturity classes from developing their full yield potential under these early planted conditions.

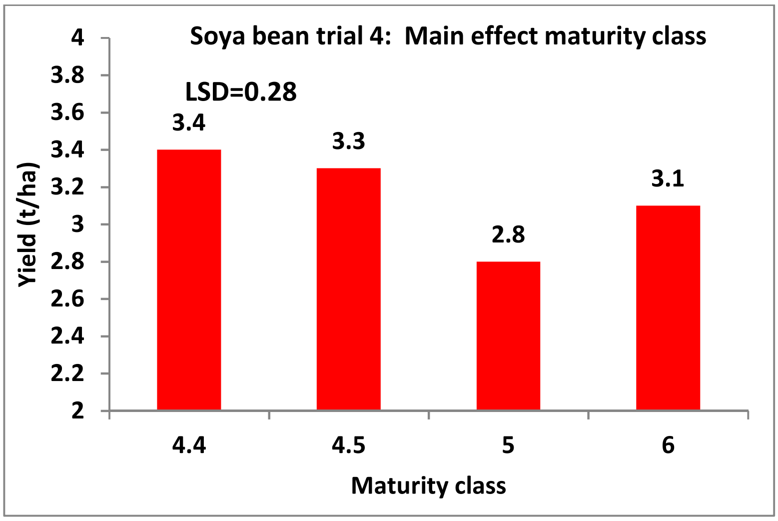
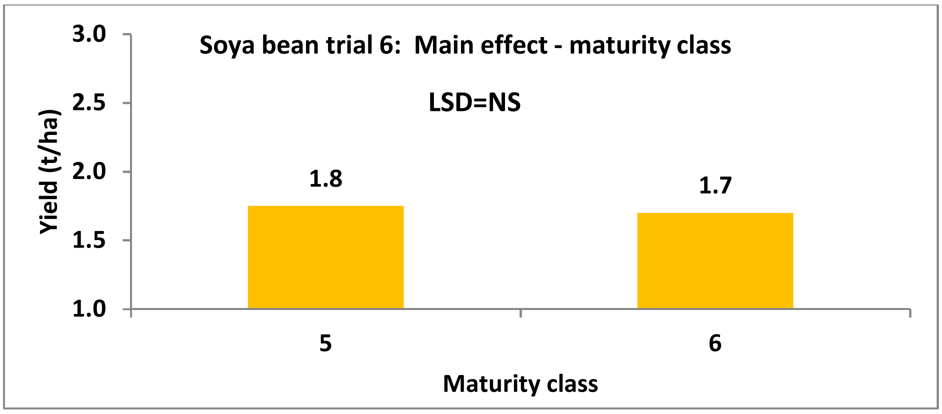


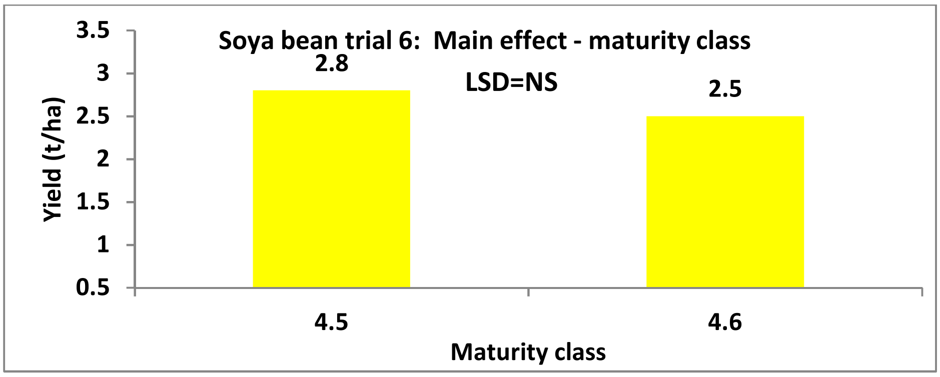
Figure 18. Main effect of soya bean maturity class on yield in Trial 2.

There was a technical problem with the short maturity classes of Trial 6, so they had to be analysed seperately from the longer classes. That is why their results are illustrated in different figures. Maturity classes 5 and 6 yielded poorly in comparison to maturity classes 4.5 and 4.6 (Figures 8.5.19a & 8.5.19b). It was expected for this late planted trial and it can be seen that the yields were generally much lower than the yields of the previous trial. Drought at the end of the season was a problem and the short maturity classes avoided the drought to a greater degree. The growing period of the longer maturity classe were also cut short by the commencement of frost which meant they could in any case not fully complete their full growing cycle.

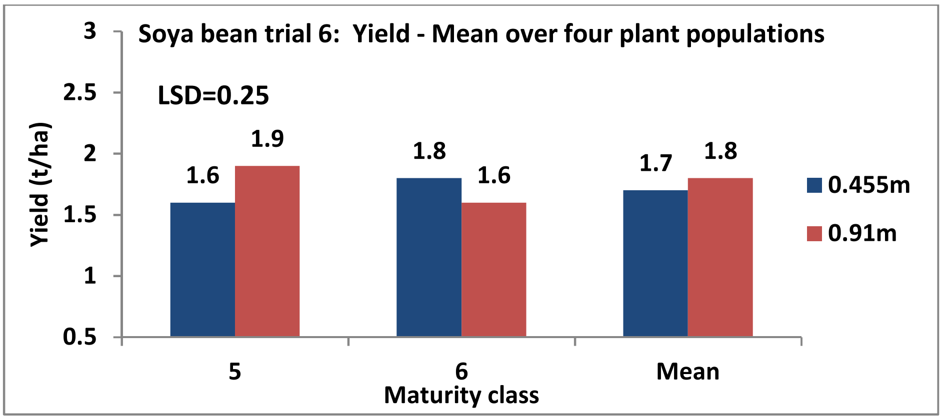
The analysis of variance did not show significant row width x maturity class interaction for the two short maturity classes. There is however, a suggestion in Figure 8.5.19d that the shortest maturity class reacted much more favourably to the narrow rows than the other maturity classes. When considering the row effects of the two longer maturity classes one should take into account that the narrow rows were generally disadvantaged by tractor wheel trampling when herbicides were sprayed twice during the season.



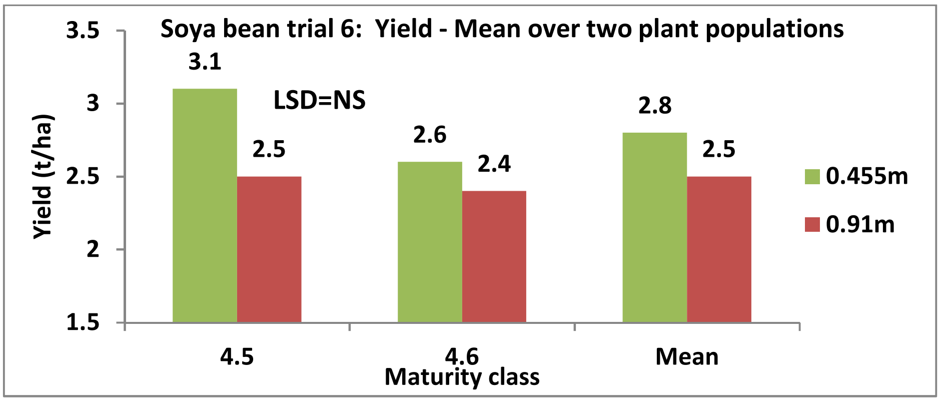
a



b



c

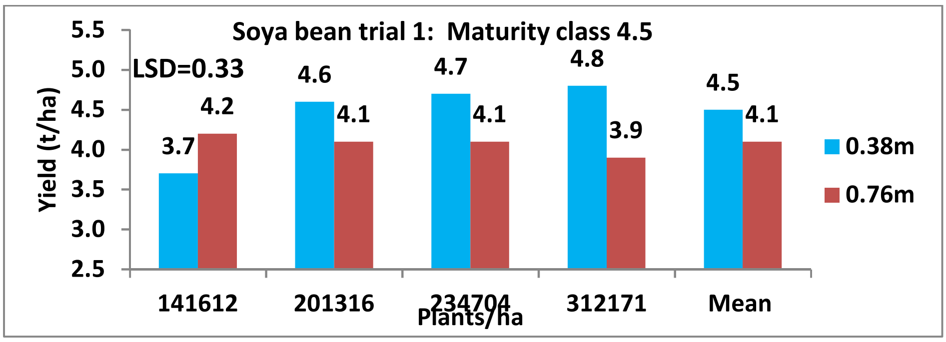


d

Figure 8.5.19. Main effect for maturity class (a & b) and maturity class x row width interaction (c & d) for soya bean yield in Trial 3.

Yield – plant population x row width x maturity class interaction

Figure 8.5.20 shows that narrow rows were generally advantageous for soya bean yield but the trend lessened for the longest maturity classes in Trial 1.



a

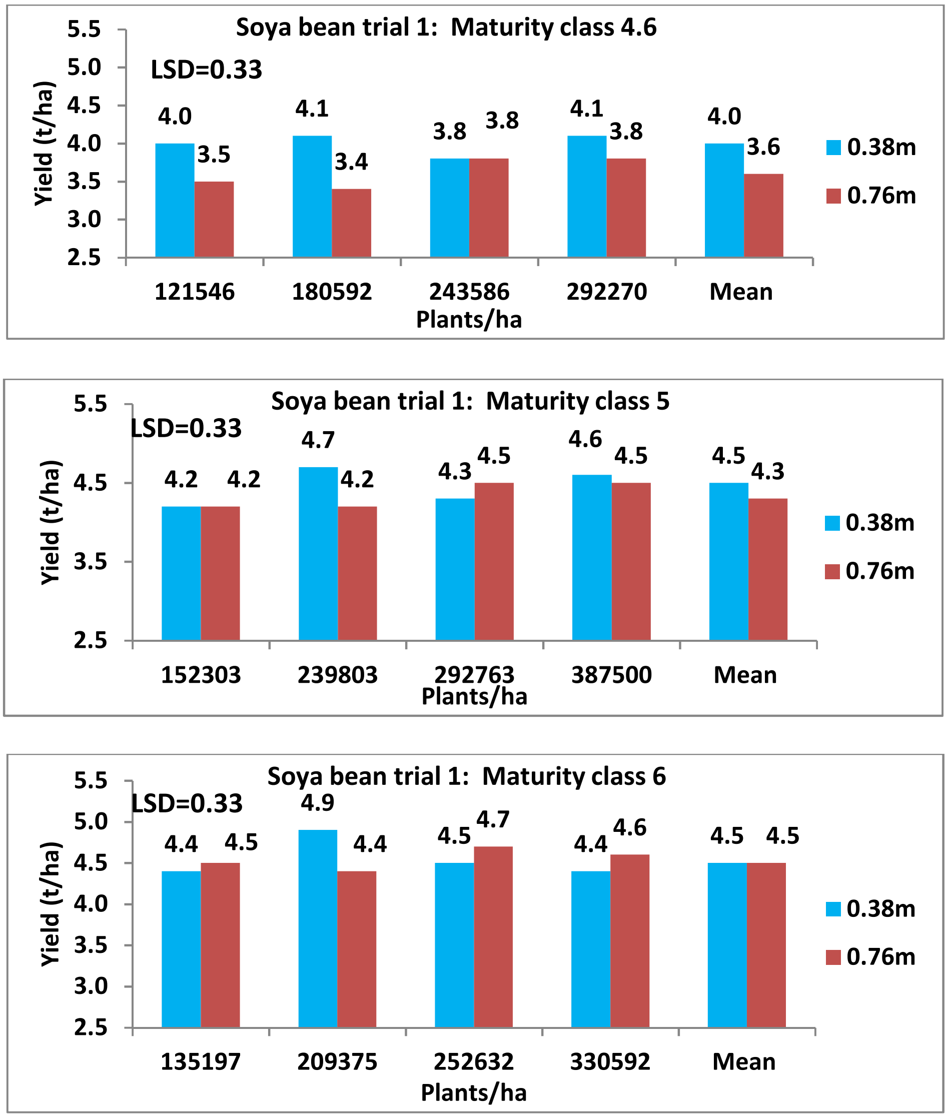


Figure 8.5.20. Soya bean yield for different maturity class x plant population x row width treatment combinations in Trial 1.

Although there was a narrow row yield advantage of 0.5 t/ha in Trial 2 it was not significant (Figure 8.5.21). The statistical procedures are however, very strict when only three replications are used to compare two treatments.

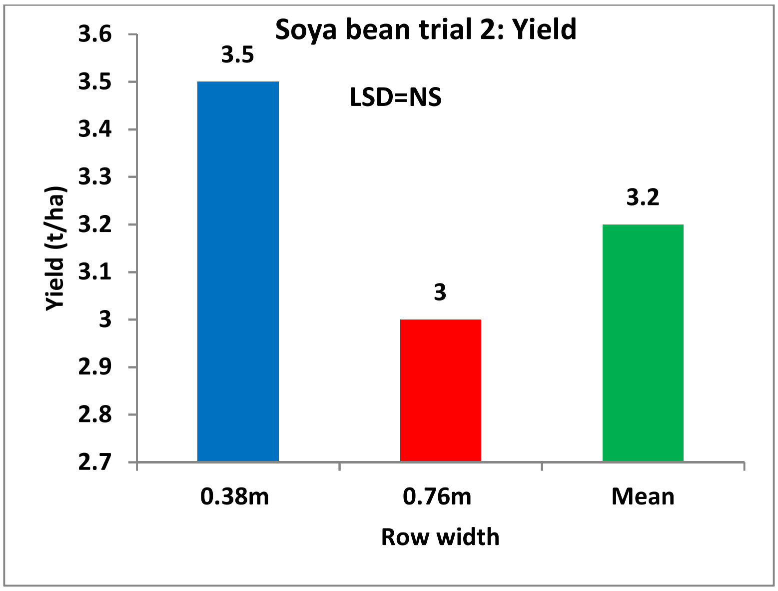
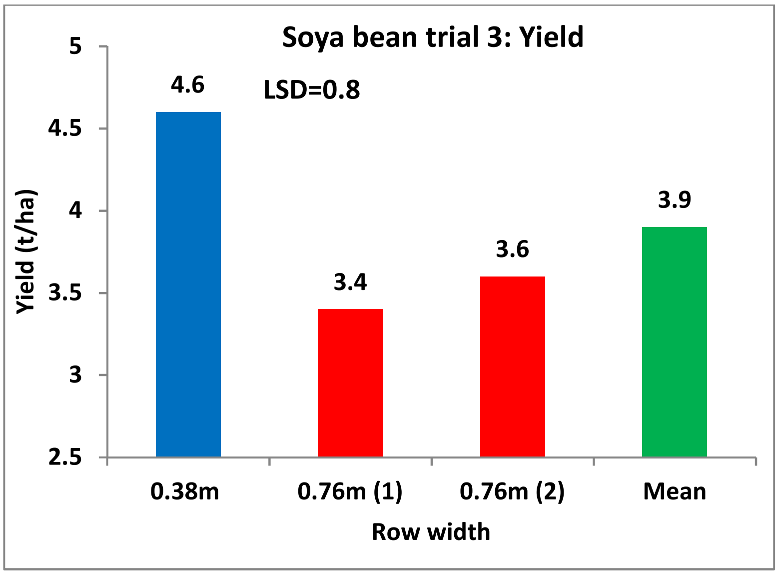


Figure 8.5.21. Yields for two row widths in Soya bean trial 2.

One of the wide rows in Trial 3 had almost double the number of plants per ha than the narrow rows. The narrow rows had a plant population of about 140 000 plants/ha and yet it yielded significantly higher than the wide rows (Figure 8.5.22).



Figuur 8.5.22. Yields for three row width treatments in Soya bean trial 3.

Figure 8.5.23 shows a trend for increased yield with increased plant population in Trial 4. The second lowest plant population treatment however, did not follow the trend so closely.

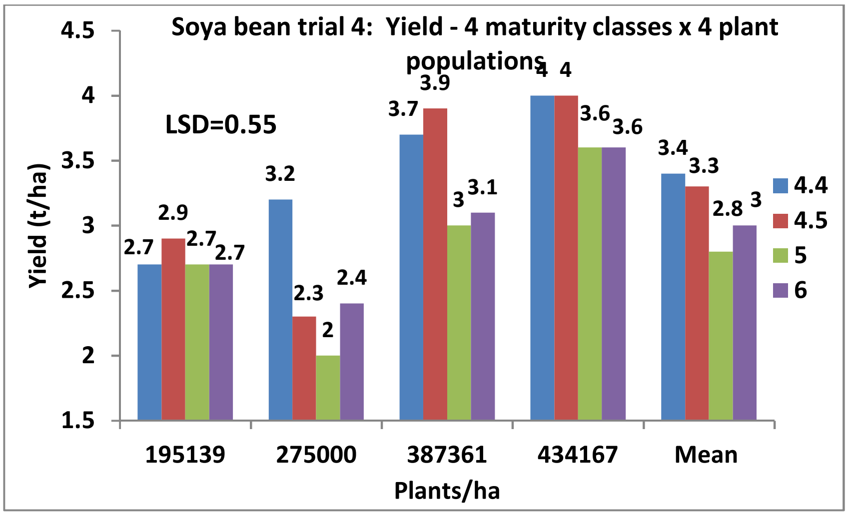
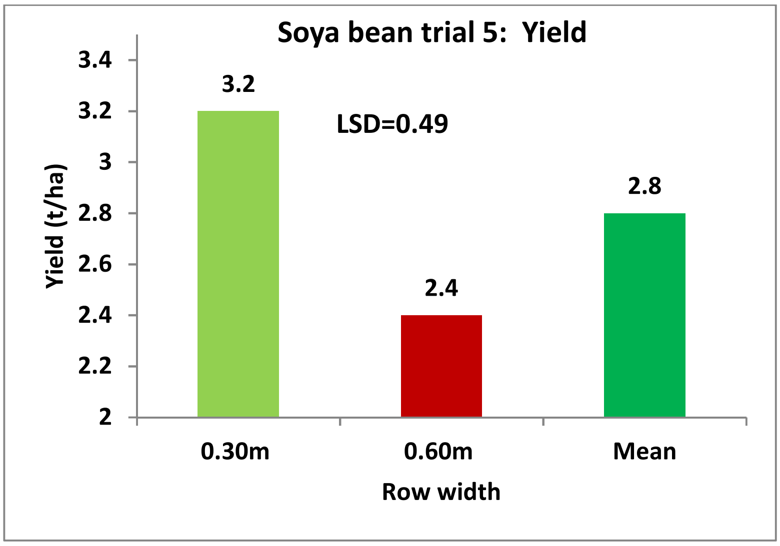


Figure 8.5.23. Yield for four soya bean maturity class x four plant population treatment combinations in Trial 2.

Figure 8.5.24 shows a remarkable yield increase for very narrow rows in Trial 5. The cultivar that was used doesn't branch very much and is therefore well suited to being planted in narrow rows.



Figuur 8.5.24. Soya bean yield for two row widths in Soya bean trial 5.

Trial 6 was planted late and the trend is a little bit different from what was previously observed. Figures 25a and 25b shows that the two longer maturity classes did not necessarily yield beter in narrow rows. It should be noted that the narrow rows were trampled by tractor wheels when herbicides were sprayed twice during the season. This was not a problem for the wide rows. It also seems that mean yields improved with increased plant population up untill the third highest population treatment after which a slight decrease was noted.

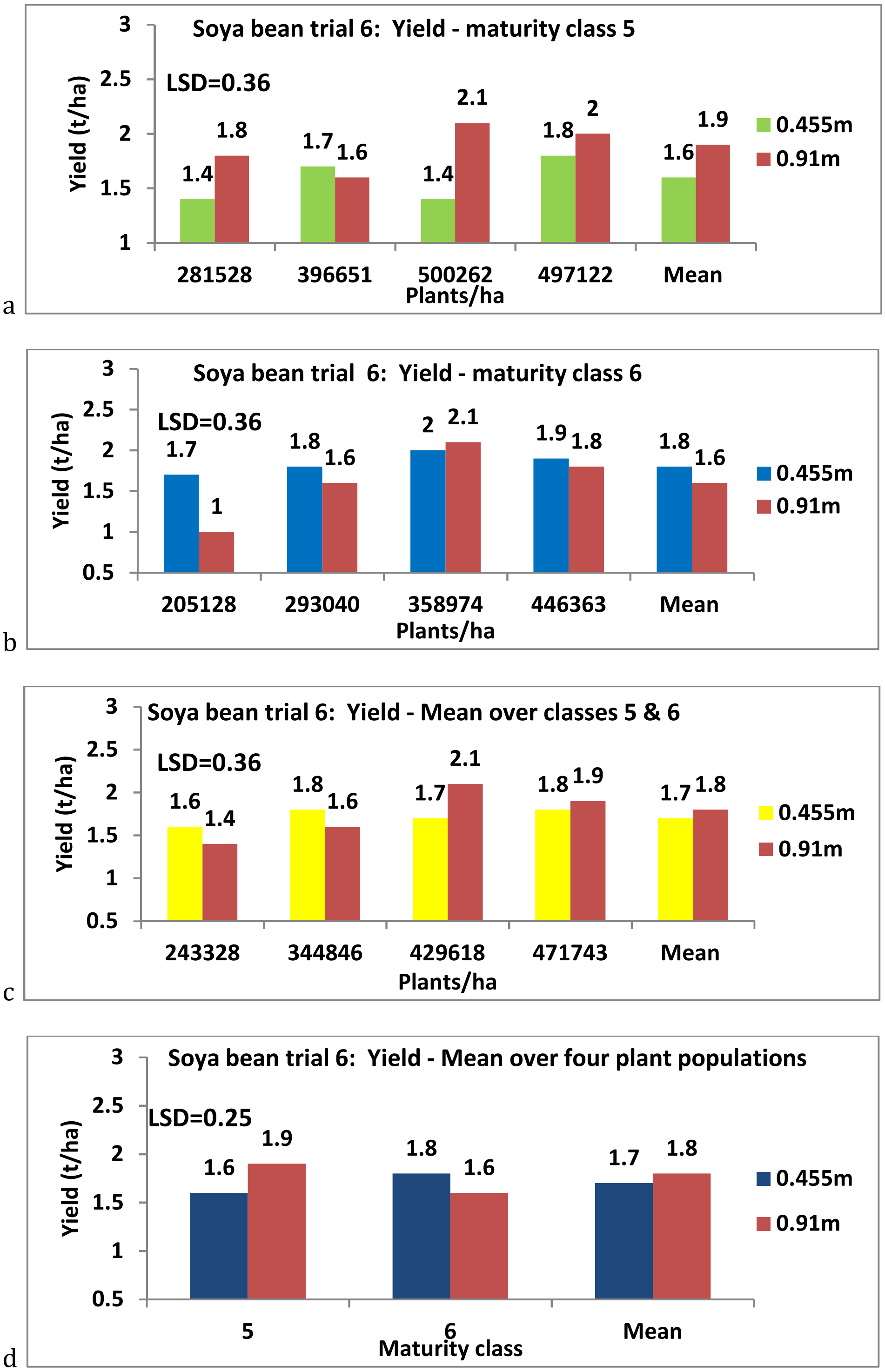
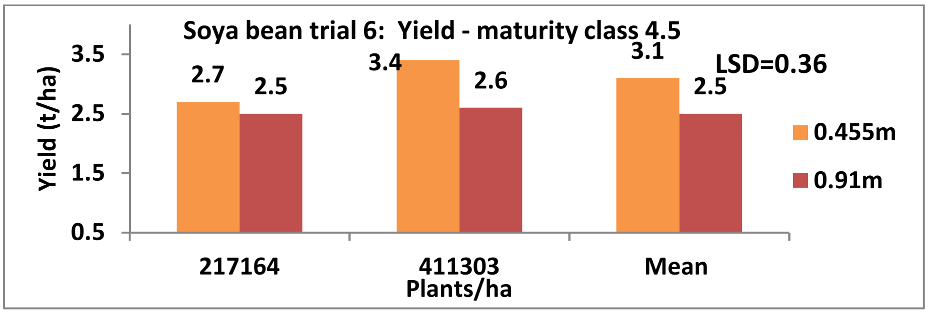
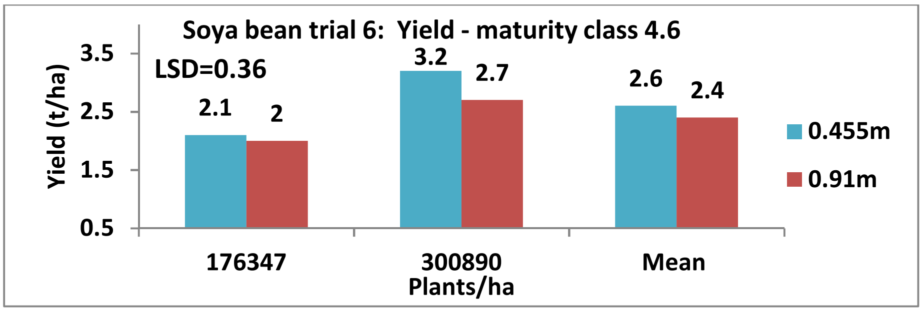


Figure 8.5.25. Yield for two soya bean maturity classes planted in two row widths and at four plant populations.

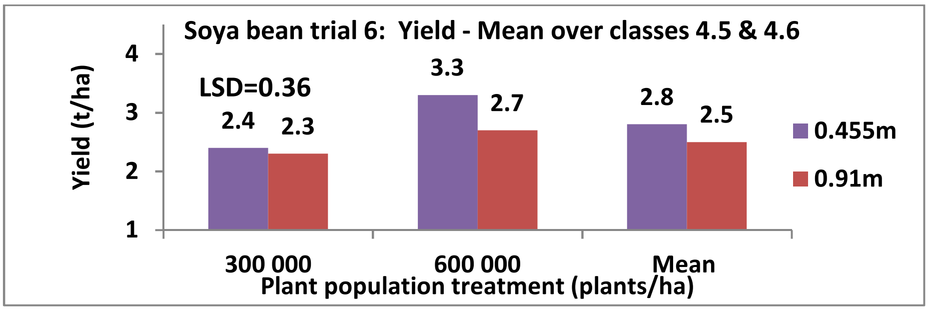
The two short maturity classes of Trial 6 were planted with only two plant populations treatments due to a technical error. It seems that the narrow rows were not affected too much by tractor wheel trampling because the narrow rows yielded more than the wide rows (Figure 8.5.26). Although the planned plant population could not nearly be achieved, the higher plant population created a significant yield increase. Mean yield for maturity classes 4.5 and 4.6 were almost 50% higher when compared to those for classes 5 and 6 in Figure 8.5.25. Late season drought thus, affected the short maturity classes less negatively.



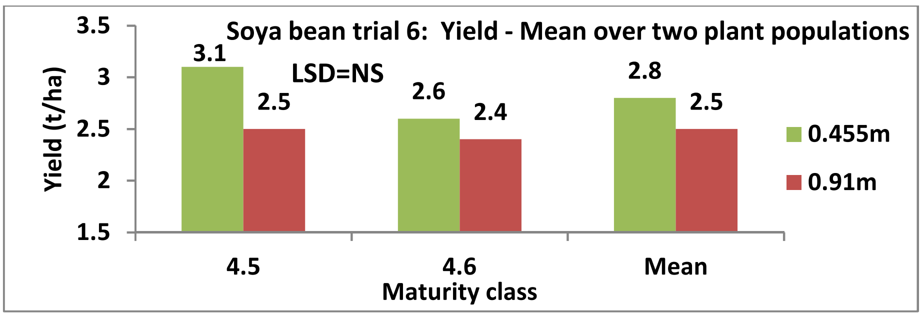
a



b



c



d

Figure 8.5.26. Yield for two soya bean maturity classes planted in two row widths and at two plant populations.

Figure 8.5.27 shows the results for a tillage trial that was started this season. There were no significant differences yet. Treatment 6 was a narrow row treatment and it might not be coincidental that this treatment yielded the best.

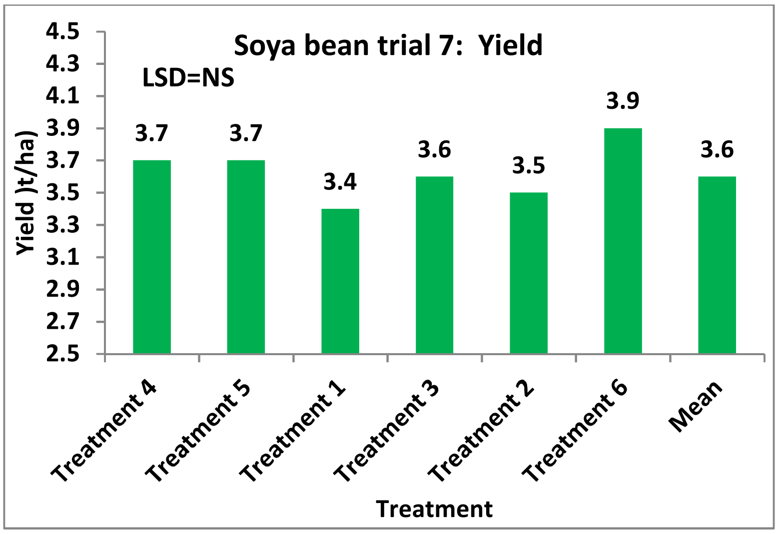


Figure 8.5.27. Soya bean yield for different treatment combinations in Soya bean trial 7.

The plant population range of Trial 8 spanned from 100 000 to 250 000 plants/ha. No significant yield differences were observed. The treatment with 100kg/ha seed should have had more plants but later emerging seedlings apparently disappeared during the season because of inter row competition.

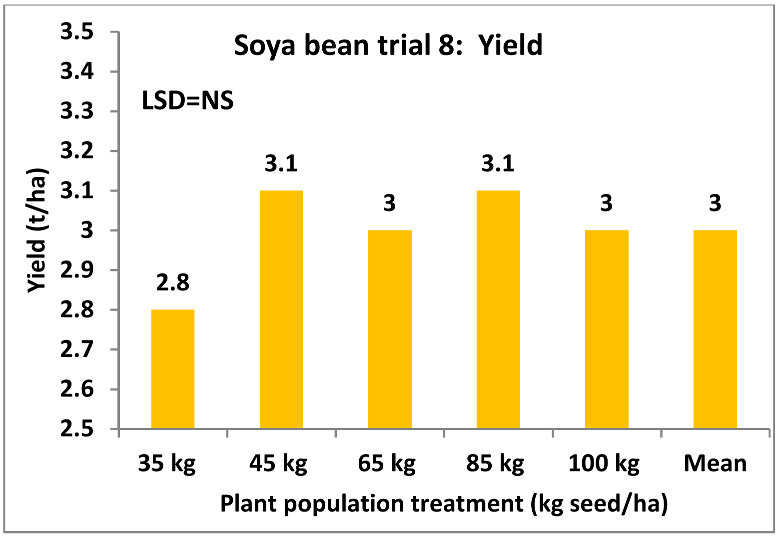
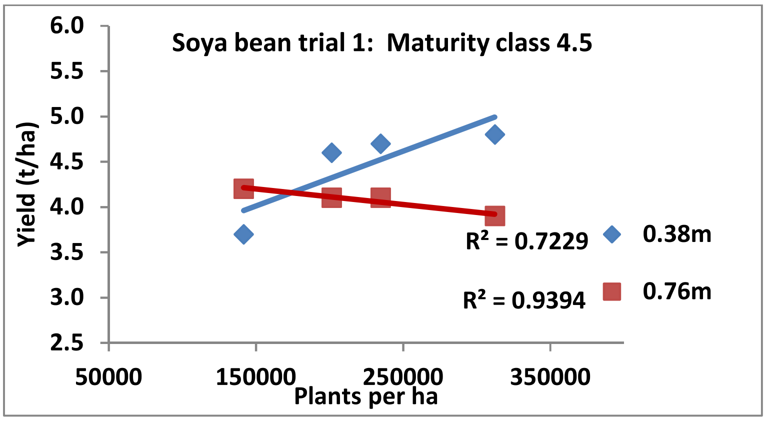
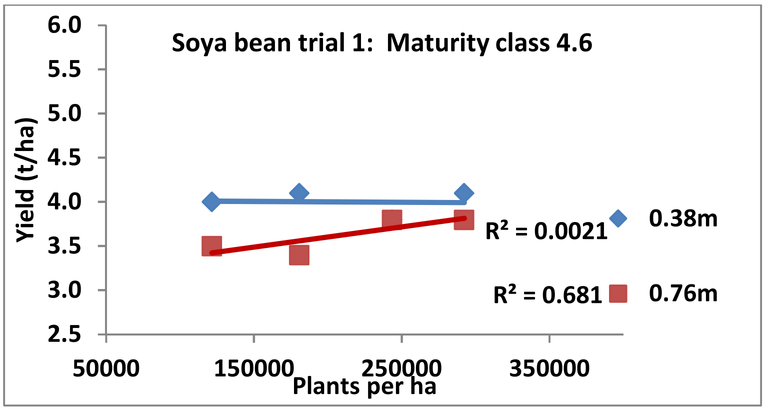


Figure 8.5.28. Soya bean yield for five sowing densities in Soya bean trial 8.

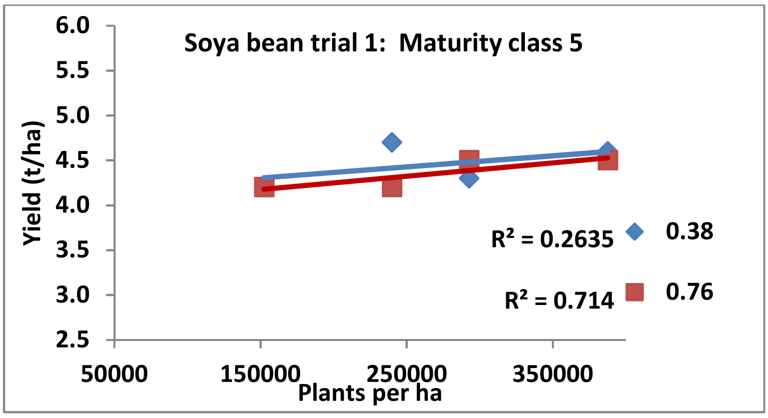
Yield/plant population correlations



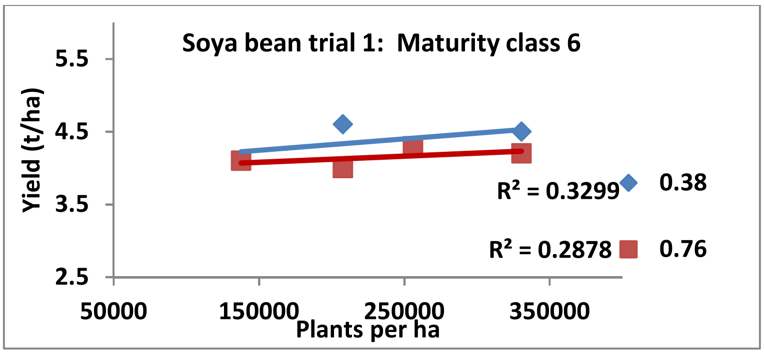
a



b



c



d

Figure 8.5.29. Yield/plant population correlations for soya beans in Trial 1.

Figure 8.5.29 shows that correlations between yield and plant population varied between maturity classes as well as between row widths. It is clear that yields must have increased incredibly fast from zero plants to the lowest plant populations. Further increases were not very significant after that. The regression lines for narrow rows were higher than those for the wide rows confirming the higher yield potential of narrow rows.

Figure 8.5.30 shows positive yield correlations for plant populations in Trial 4. The two short maturity classes yielded consistently better than the two longer maturity classes. It was previously stated that a late season drought prevented the longer maturity classes from reaching their full potential.

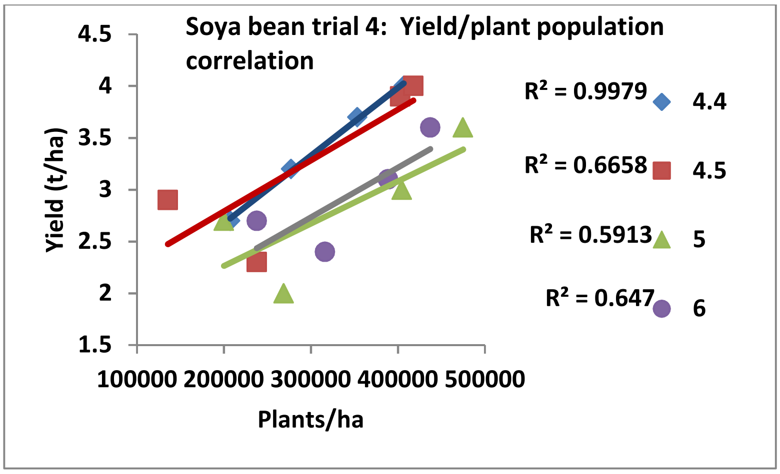
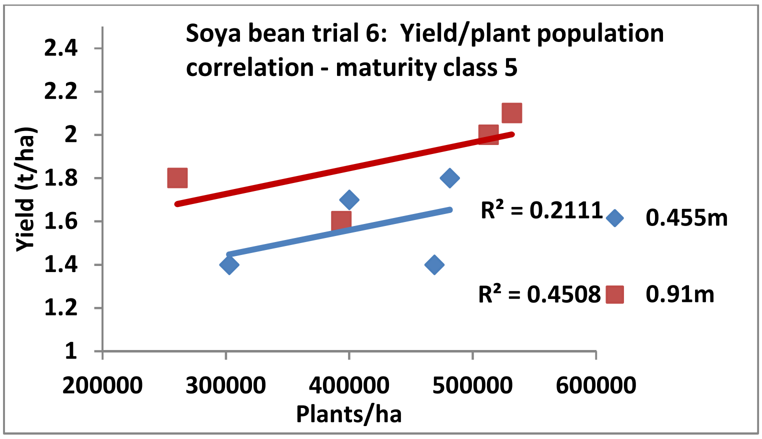
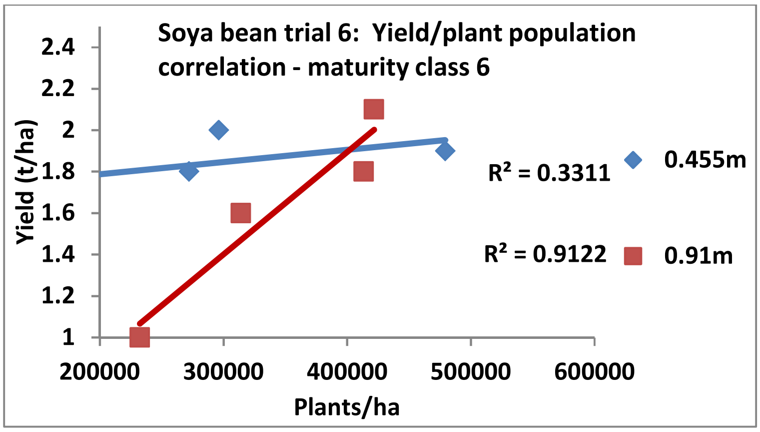


Figure 8.5.30. Yield/plant population correlations for soya beans in Trial 4.

Trial 6 is comparable to Trial 4 in terms of elevation above sea level and type of soil. The only real difference was the late planting date of this trial. The positive yield response to increased plant population is obvious according to Figure 8.5.31. One shouldn't read too much in the narrow row correlations because these treatments were trampled on by a tractor spraying herbicide and they were subsequently injured twice during the season.



a



b

Figure 8.5.31. Yield/plant population correlations for soya beans in Trial 3.

Trial 7 consisted of different treatment combinations of which three were specifically planted at different plant populations. All the other treatments were included to determine a yield curve for varying plant populations. Figure 32 shows a very low correlation between yield and plant population. The highest plant population and yield were achieved in narrow rows but yield differences were not statistically significant.

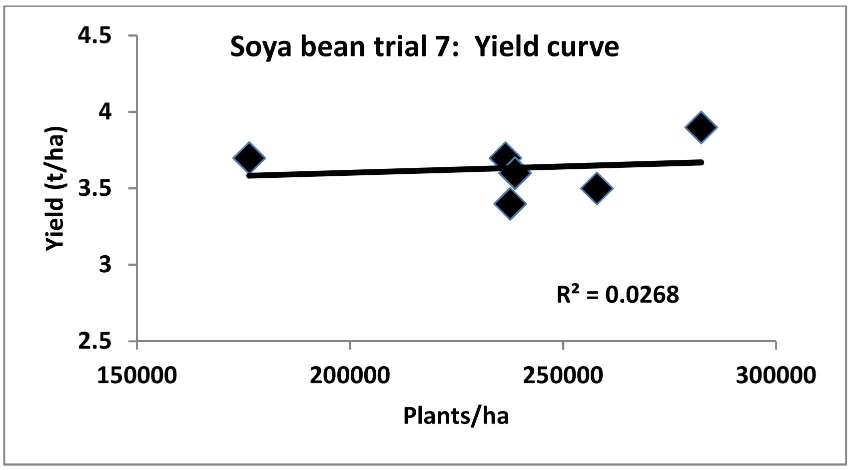


Figure 8.5.32. Yield curve for varying plant populations in soya bean trial 7.

Figure 8.5.33 also shows very little yield responses to increased plant population. It was only the lowest yield that was significantly lower than the rest. One would have expected a bigger range from seeding levels ranging from 35 kg/ha seed to 100 kg/ha. It was noted that a lot of plants at the higher seeding levels dissappeared during the season, possibly because of competition difficulties when some plants emerged a little later than others.

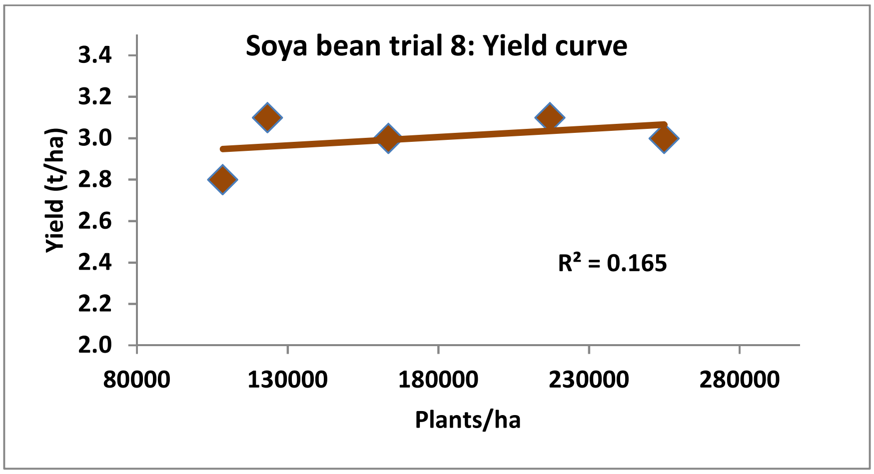


Figure 8.5.33. Yield curve for varying plant populations in Soya bean trial 8.

Morphological development

Tables 8.5.1 to 8.5.3 were analysed and with the help of more information than what is shown here, one could conclude that every week's delay in planting date, delays harvesting date by 3 to 4 days. This means that a delay in planting date of five to six weeks causes the growing period to be shortened by about three weeks. The shortened growing period substantially impacts on the yield potential of soya beans especially the long maturity classes whose grain filling periods are shortened. Long maturity classes have the highest yield potential when planted early but they bring increased risk into the production system because their grain filling period usually coincides with the period of the season when one can expect a drop in rainfall (last part of March and beginning of April).

Morphological differences between maturity classes could not be determined very accurately because the trials could only be visited once a week and differences are sometimes measured in terms of a few days. However, it seems at this early stage of the research project that one can conclude that maturity class 6 should not be planted later than the first week of November. Maturity classes of 4.6 and shorter can still be planted during the first two weeks of December and they will still have enough time to complete their growing cycles before the normal frost date of middle April. Narrower rows can compensate for lower yield potentials due to late planting.

Figure 8.5.34 shows how maturity class interacts with planting date. Maturity class and growing period is correlated and it can be seen that the longest growing periods produce the highest yields. The trend is reversed when late planting is done. The shortest growing periods are then more beneficial.

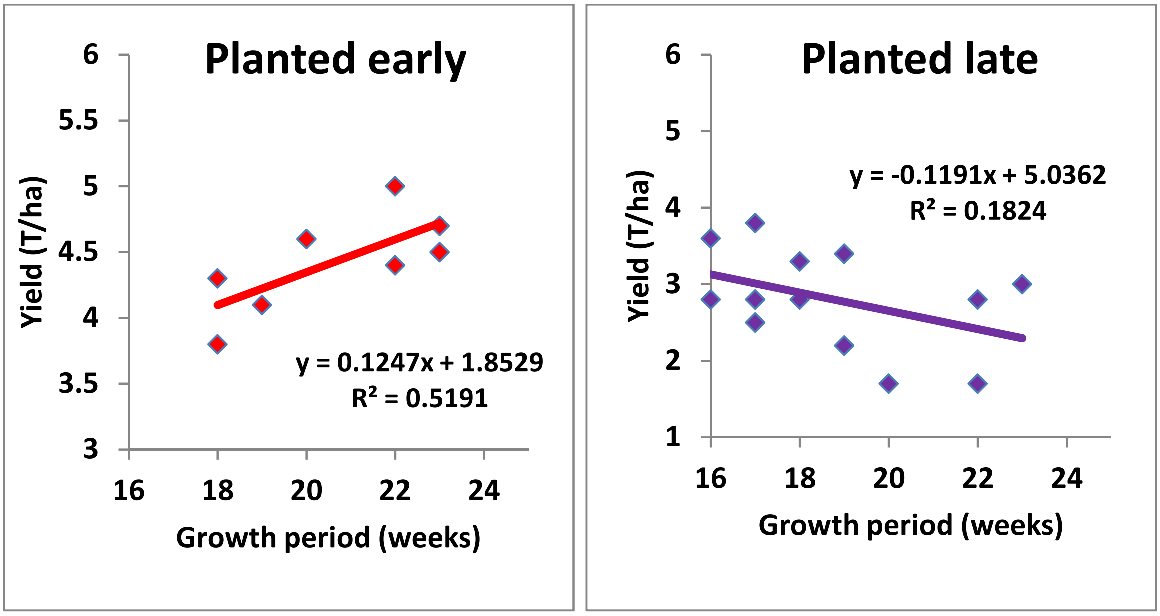


Figure 8.5.34. Effect of maturity class (growth period) and planting date on soya bean yield.

Table 8.5.1. Trial 1: Soya bean morphological development for four maturity classes.

	Maturity class			
	4.5	**4.6**	**5**	**6**
Morphological period	Weeks			
Planting – R1	6	6	10	11
R1 – R5	5	5	5	6
R5 – R8	7	7	7	6
Total growing period	**18**	**18**	**22**	**23**
Frost date	24			

Table 8.5.2. Trial 4: Soya bean morphological development for five maturity classes.

	Maturity class				
	4.5	**4.4**	**4.6**	**5**	**6**
Morphological period	**Weeks**				
Planting – R1	7	8	7	11	12
R1 – R6	4	3	4	5	4
R6 – R8	7	8	7	6	7
Total growing period	**18**	**19**	**18**	**22**	**23**
Frost date	23				

Table 8.5.3. Trial 6: Soya bean morphological development for four maturity classes.

	Maturity class			
	4.5	**4.6**	**5**	**6**
Morphological period	**Weeks**			
Planting – R1	7	7	11	12
R1 – R6	3	3	4	4
R6 – R8	7	7	5	6
Total growing period	**17**	**17**	**20**	**22**
Frost date	19			

CONCLUSIONS AND RECOMMENDATIONS

Soya bean plant population

Plant populations nearing 100 000 plants/ha can produce very satisfactory yields. One would, however not recommend that producers when planting, should aim for such low plant populations. The mortality rate of soya beans can be very high and unforeseen circumstances such as the occurrence of hail could lower low plant populations very drastically. Low plant populations will also enable gaps to form easier in the row when plant losses occur. Gaps represent areas that are lost to production and the compensatory ability of crops are not enough to compensate for lost area. The findings of this research, in terms of how high yields can still be reached with low plant populations, is relevant when decisions have to be made whether to replant or not when hail damage occurs early in the season.

It should be noted that the ability of soya beans to compensate for plant population variation should also be dependent on the growth type and branching capability of a specific cultivar. More research will be needed to fine tune present recommendations.

Soya bean row width

Very good rainfall was measured this year which caused even small frame cultivars to grow so high that they began to topple over. It was a year that did not really favour narrow rows because plants needed all the space they could get to expand. The techniques used, furthermore did not favour narrow rows. Plants in these rows were in fact harmed by the compaction and trampling effect of the planting process where the narrow rows were obtained by double planting with a wide row planter. Some narrow row plots were further harmed by crop spraying during the season where a tractor driven sprayer had to be used instead of a self-driven very wide boom sprayer that does not need to drive through the experimental plots. Considering these constraints it was a surprise to observe the positive yield effects of narrow rows.

Yield increases were even noted when already narrow rows of 0.6m were further narrowed to 0.3m. When looking at the response of pod numbers per plant there was a suggestion that rows of 0.3m were getting a bit narrow in terms of inter plant competition. Experience with a planter that could plant 0.38m rows showed that this might be the borderline row width in terms of practicality. Difficulties were encountered with plant stubble flow when the amount of stubble increased past a certain threshold.

Soya bean planting date and maturity class

Planting date and maturity class interacts with one another and cannot be considered separately. All the maturity classes under consideration were more or less influenced to the same degree in terms of delayed harvesting date when planting dates were delayed. It was a surprise because the early planted short maturity classes did not need a day length shorter than our longest days to commence flowering. They flowered before December 22 when day lengths had not yet shortened. The longer maturity classes started flowering from middle January and onwards. It seems that the planting date and choice of maturity class should be done in such a way as to ensure flowering by the end of January. Such a flowering date will ensure a reproductive period of between 10 to 12 weeks which should be sufficient for maturity classes 6.4 and shorter.

It was clear that the long maturity classes should be planted first so that they can utilise a full season to reach their full yield potential. Considering the time they need to complete a growing cycle it seems that maturity classes 6 to 6.4 (data not shown for maturity class 6.4) can be planted until the first week of November. Shorter maturity classes should be used for the next two weeks. Maturity classes 4.6 and shorter can be planted into December. Common yield determining factors to consider are late season drought which is common and the arrival of frost. Early planting or the use of short maturity classes will minimize the risks associated with these factors. Narrow rows will offset the lower yield potential of short maturity classes.

9. Project budget

The project budget and expenditure to date (August 2017) for both study areas is indicated in **Table 9.1** below as per work package and activity.

Table 9.1: Project budget and expenditure at August 2017

Description	Total Actual YTD Aug 17	Total Budget YTD Sept17	Available to use
Reitz: Soil	-	71 750	71 750
Vrede: Soil	-	71 750	71 750
NE FS: Cover crops	800	172 000	171 200
Reitz: Agronomy	12 774	76 500	63 726
Vrede: Agronomy	13 574	78 750	65 176
Reitz: Grain SA	72 443	167 500	95 057
Vrede: Grain SA	15 159	60 000	44 841
Reitz: Farmer Facilitation	3 648	38 700	35 052
Total	**118 398**	**736 950**	**618 552**