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**CONSERVATION AGRICULTURE
FACILITATOR
PROGRESS REPORT**

October 2021 to September 2022

**Submitted to:
The Maize Trust**



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Executive Summary

The following is a summary of the progress of the Conservation Agriculture (CA) Farmer Innovation Programme (FIP) in the 2021-2022 season:

Problem statement

According to literature many environmental problems such as soil degradation and its associated socio-economic consequences are caused by, among others, tillage-based crop production practices. Soil degradation (e.g., soil erosion and fertility loss and its off-site environmental effects such as sedimentation, siltation and eutrophication of water ways or enhanced flooding) is a threat to the sustainability and profitability of especially grain production. These negative effects of soil degradation pose a threat to food security and eventually poses a risk to national security.

The question at stake herein is to which extent, if any, can no-till and CA practises (including the introduction of livestock) mitigate the effects of tillage-based crop production in the summer rainfall area of South Africa?

Summary of the CA FIP approach

The CA FIP follows a farmer-centred (participatory) systems research approach using on-farm trials strategically positioned and scientifically designed in the key summer rainfall grain production regions of South Africa. The programme works closely with local CA farmers or study groups and suitably qualified researchers, to design and implement on-farm trials and related project activities. The programme addresses various CA research questions in these trials and compare different production systems. The CA FIP selects and monitor a selection of indicators on soil health, biodiversity, production, efficiency and financial performance, and share the results via farmers days, conferences, articles, videos and social media.

CA FIP Processes

Good farmer co-workers, groups and trials sites were identified in all project study areas.

Scientific collaboratively managed trials (CMTs) were designed including relevant treatments according to problems and issues identified by project teams, especially farmers.

All the CMTs were established successfully in all the projects. Farmer co-workers have been cooperating exceptionally well. A few challenges with some of the treatments or sites were identified and solved, or improvements planned for the next season. The inclusion of organic and biological fertilisers as part of best practice CA treatments on the commercial trials are planned for 2022-23.

Analysis of data collected from on-farm trials and monitoring points is viewed as a critical step of all the projects. Large amounts of data were collected, which need to be well managed, analysed and interpreted. Care has been taken to address this adequately and a continuous effort to explore and interpret key indicators, such as soil health and profitability.

Awareness of CA forms a critical impetus for the innovation process. After a two-year period of reduced awareness activities due to Covid19, the events have started in new urgency. The smallholder farmers day on 2 March in Bergville, the Reitz conference on 7 and 8 March, the Ottosdal farmers day on 10 March, and the Maluti and Mpumalanga farmers days on 10 and 12 May, were held successfully.

The ASSET Research symposium was held on 14 March at the University of Stellenbosch. From 20-22 July 2022 the National Conservation Agricultural Task Force (NCATF) meeting was held in Klerksdorp, involving mostly government officials from national and provincial Landcare units; Dr Hendrik Smith gave feedback on CA FIP projects and Mary Maluleke (junior economist at ASSET Research) gave a presentation on the results of an economic analyses of different farming systems measured in the CA FIP projects. A field visit to the Ottosdal study area was also organised.

CA FIP outputs

Planning workshops for Maluti and Mpumalanga Highveld projects were held in August and September 2021. Farmer co-workers and sites were selected. Annual Ottosdal planning workshop was held in September 2021. Planning processes for smallholder projects in KZN were held in September to October 2021.

The following main collaboratively managed trials (CMTs) were designed and established: Maluti: Marquard (x1), Clocolan(x1), Mpum Highveld: Kinross (x2), Standerton (x1), Ottosdal (x4), KZN smallholders (x40) + 90 FMTs

The main field work activity to collect soil samples and other parameters for Maluti and Mpum Highveld projects was in February 2022; Ottosdal collected soil samples in March and yield data only in September 2022; KZN smallholder projects collected data from January right through to August.

Completion of field monitoring with farmers, most especially important process with smallholder farmers in KZN, which was using CA facilitators on various levels, as well as technical team members.

Analysis of data collected from on-farm trials and monitoring points was done for each project. In some cases, such as Maluti and Mpumalanga Highveld projects, specialist data management analyst was hired to assist. Economic analyses have become a core element of the CA FIP projects and a separate economic modelling analysis study has been done on all the commercial projects at this stage.

Well organised and -attended awareness events were held in March and May 2022 at all the project sites.

Various articles, videos and presentations were made and/or published and can be accessed on the ASSET research website.

Major project meetings, especially with farmer co-workers, groups and staff were continuously held to communicate, coordinate and plan various project activities, but especially trial treatments and practices.

Six-monthly and annual reports were completed and submitted according to MT specifications.

CA FIP Results

Impact

A first attempt to assess the impact of the CA FIP has been made and discussed in this report. These results show that the CA FIP have an exceptional positive impact on the a) immediate sphere of control and influence (direct impact or 'footprint') through project activities, b) indirect sphere of influence (wider impact or footprint) through awareness events, and c) growth in CA adoption.

Dissemination and capacity building

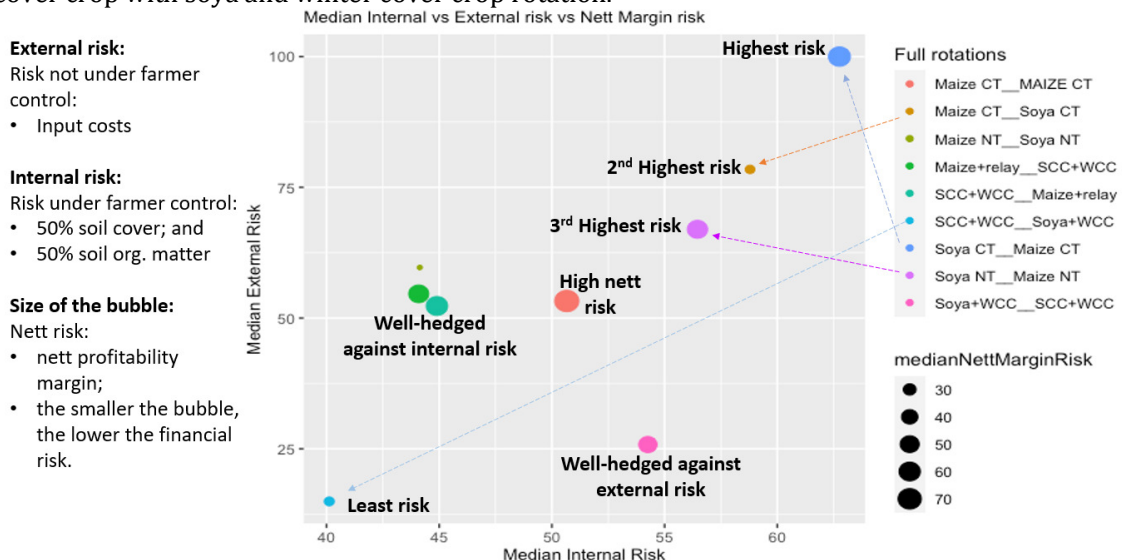
Various articles, videos and presentations were made and/or published and are all available on the ASSET Research website.

Four on-farm research projects were continued and are running smoothly at this stage: three commercial projects (Ottosdal, Maluti and Mpumalanga) and one smallholder project (KwaZulu-Natal). At this stage, these projects have shown acceptable success, progress and impact with expected milestones being achieved.

The need for support and advice among farmers to implement and adapt CA in their unique realities (contexts) is creating a serious need for people with the appropriate skills and capacity. In that respect the CA FIP and ASSET Research have been involved in the following capacity building initiatives: i) an online short course in CA, ii) CA curriculum development at the Reitz Agricultural Academy, and iii) tertiary training support at graduate and postgraduate level.

Risk assessment: Commercial farmers

The outcome of a risk analysis of twenty-four (24) treatments of three production systems (CT, NT & CA) on four (4) on-farm trials over two years in the Maluti and Mpumalanga Highveld projects are shown below. It shows that the highest risk system is conventional tillage (CT) soya and maize rotation, while the system with the least risk is the CA double cover crop with soya and winter cover crop rotation.



Smallholder farmers

In the smallholder CA research project, runoff measurements averages across all CA trial plots (with maize-bean intercropping) were almost 30-50% lower than runoff in the control plots (CA control maize-mono cropped), implying much less soil erosion and much more water in the soil (i.e. 694 000 L/ha per year more water in the soil and available to crops). Yield advantages for maize through intercropping and crop rotation are evident after a continuous CA implementation cycle of 4 or more years: average yields measured on the research trials were: maize-intercrop - 5,22t/ha, maize-monocrop - 4,18 t/ha, and maize-control - 2,87t/ha.

Maximum yields have increased from 6,7 t/ha to 13,6 t/ha between 2014 and 2021, for high performing CA smallholder farmers (please note that plots are <1ha, but the results have been expressed in /ha terms for comparison purposes). A yield gain of ~1 t/ha per annum is possible under CA cropping systems despite difficult climatic conditions.

CA FIP Research going forward

For the 2022-2023 season CA projects, the CA panel reviewed all CA project proposal and bi-annual reports submitted in March 2022, which were subsequently also recommended to The MT by the Maize Forum Steering Committee (MFSC). The results of a CA survey done by Grain SA in August 2022, prompted the CA FIP to make amendments to the proposals submitted in March, which was then submitted to the MT on 2 September 2022. This amendment paves the way for some critical and constructive changes on the following aspects of the CA FIP projects going forward: i) the implementation and management of the work packages, ii) monitoring and termination of the projects, and iii) analysing the relative profitability of the various production systems. These amendments are applicable to the existing and new CA projects and will be followed from the 2023-24 season.

Conclusion

This report reflects the results at the end of a two-year research cycle on the commercial study areas of Mpumalanga and the Maluti grain production areas. The CA-production system used in the trials are based on a four-year rotation system. At the half-way mark of the first rotation the preliminary results, while varied, indicate that CA and no till systems do indeed contribute to the mitigation of the negative side-effects linked to tillage-based crop production systems in the summer rainfall area of South Africa. The preliminary results indicate further that while there might not be significant differences with respect to yield, CA and no-till are beneficial to profitability. They also reduce the producer's risk to external and internal shocks by hedging (at least in part) against increases in the prices of external inputs and the enhancement of soil-based resilience. In addition to these, among the smallholder farmers CA contributes much to food security and water use efficiency.

1. INTRODUCTION

The introduction of Conservation Agriculture (CA), financially supported by The Maize Trust (MT) and the Winter Cereal Trust (WCT), was seen as one of the key strategic thrusts in sustainable production through improved resource conservation and production efficiency in the grain industry. Research on improved CA and/or crop production systems, improved soil health, integrated pest management, integrated soil nutrient management, integrated weed management and the integration of livestock, are some of the key research focus areas. In 2013 it was decided to create a post within the structures of Grain SA, with the primary purpose to facilitate the promotion of CA among grain producers in South Africa. Since 2019 this post moved to ASSET Research, from where the CA FIP has been implemented and coordinated. This post is funded through the MT, with some running costs funded by the WCT, and now SAWCIT. This report will cover the October 2021 to September 2022 period of business by the CA Facilitator at ASSET Research (<https://assetresearch.org.za/>).

The CA FIP concept development confirmed that the model for CA research and development (R&D) that evolved during the last few decades (global and local) does not follow a linear process – the actual change and innovation processes are much more complex and diverse. This revelation means that complex, multi-component technologies such as CA require the development of innovation systems (IS) to adapt technologies to local conditions. Accordingly, and at the very least, the emphasis has to be on various aspects of the system, of which on-farm research and the inescapable experiential, discovery and social learning that this generates are key elements; all of which critically place the farmer in the central role.

Following the above statement, the CA programme has been designed and described under the paradigm of IS and was named the CA Farmer Innovation Programme (FIP). The emphasis of the FIP has been to channel, facilitate and coordinate funds to active CA farmers and their groups or projects (including technical and agri-business co-workers), who wish to test, adapt, develop and adopt CA innovations on practices, topics and issues. The idea is that easier and better flow of such funding would allow a wide and relevant range of CA innovations to be investigated and demonstrated by and with farmers in their realities, and with proper technical support and facilitation, which may expand awareness and innovation capacity among farmers, other rural stakeholders, ultimately facilitating the efficient adaptation of CA in various regions of the grain industry.

The CA FIP was instrumental to establish the core structure and elements on behalf of and for the effective application of MT funds. In short, FIP facilitation and coordination in CA research will be through solicited and non-solicited projects funded by The Maize Trust (MT). Proposals will be invited and submitted per the MT funding cycle (i.e. by 31 March and 30 September each year). Once these are received by the MT, they are directed to Dr Smith at ASSET Research, who will coordinate a CA panel to assist with the evaluation of the projects according to specific FIP criteria.

2. CA FIP STRATEGIC GOALS

The key research question:

Does CA improve farm productivity, efficiency, sustainability and profitability, and what are the regional variations thereof?

The main goal or long-term objective of the CA FIP:

The long-term objective of the CA FIP is to enhance the profitability and sustainability of maize production systems for a range of diverse and unique situations in different regions of South Africa.

To reach this long-term objective, the CA-FIP has developed an implementation framework with *short-term objectives, activities, outputs and outcomes*. This framework is implemented through approved CA FIP projects and work packages which are reviewed four (4) years after implementation. Recommendations are then made to extend the research, or to terminate the project.

CA FIP short-term objectives:

1. To identify and select target regions, research locations and participants
2. To implement appropriate on-farm research according to needs and priorities identified
3. To implement a monitoring and evaluation framework and process
4. To create wider awareness and innovation capacity in the selected study areas and the broader grain production region on the practices and benefits of locally adapted CA systems.
5. To support communication, education, facilitation and reporting.

Objective 1: To identify and select target regions, research locations and participants
Key activities
a) Use appropriate agro-ecological delineation as basis to select a specific target region(s) b) Identify and engage with active and interested farmer groups (volunteering, where there is a demand) as platform(s) for implementation c) Facilitate a participatory diagnosis (of problems, challenges, etc.) and planning process with farmer groups and other key stakeholders d) Identify research locations on specific farms and ecotopes for collaboratively managed trials (CMTs) and farmer-managed trials (FMTs).
Objective 2: To implement relevant on-farm trials according to needs and priorities identified
Key activities
a) Prepare, establish and manage on-farm trials on selected sites (farms) b) Implement and manage research activities through appropriate work packages around key research topics, questions and milestones
Objective 3: To implement a monitoring and evaluation framework and process
Key activities
a) Participatory monitoring / data collection b) Farmer participatory M&E c) Data analysis, evaluation and impact assessments

Objective 4: To create wider awareness and innovation capacity in local farming communities on the practices and benefits of locally adapted CA systems.
Key activities
a) Annual farmers days or conferences b) Communicate experiences and results c) Education and training d) Exposing on-farm trials to interested farmers and other
Objective 5: To support communication, education, facilitation and reporting
Key activities
a) Project meetings for feedback and planning b) Farmer facilitation and coordination c) Stakeholder communication and involvement d) Reporting

Short-, medium- and long-term outcomes:

The implementation of the CA FIP with appropriate on-farm CA systems research approaches will lead to the achievement of the following measurable outcomes over the short-, medium- to long-term:

Short-term outcomes (easily in reach of project influence):

- Involvement of and ownership by key stakeholders, especially maize producers, research institutions, input suppliers, etc., in CA FIP projects and activities.
- An increased level of CA awareness and knowledge of producers and other key stakeholders in the different study areas.
- An increased level of interest, willingness and skills among producers to test and adapt CA principles in their own contexts.

Medium-term outcomes (well in reach of project influence):

- Highly innovative and adaptive CA farmers.
- Increased adoption of CA systems in different regions.
- A reversal in cost-pressure and declining gross margins of maize farming enterprises
- An improvement in net margins (profitability) of maize farming enterprises.
- Increased water infiltration that reduces runoff, soil erosion and sedimentation, and improve surface and groundwater levels and quality.

Long-term outcomes (in reach of project impact, but also being influenced after project termination):

- The restoration of soil health and soil ecosystem services.
- Competitive, stable yields with the use of less external synthetic production inputs.
- Sustained higher net margins (profitability) of maize farming enterprises.
- A reversal of the negative effect of agriculture on greenhouse gas emissions and global warming.
- A positive impact on climate change and weather patterns, water regimes, biodiversity and ecosystems services.
- Increasing the resilience and sustainability of farmers.
- An improvement in the resource use efficiency and competitiveness of farming practices.

- Restoring the status and image of farming, which has been severely damaged by a negative environmental footprint.

3. PROGRESS AND RESULTS: SHORT-TERM OBJECTIVES, ACTIVITIES, OUTPUTS AND OUTCOMES

Table 1 below is a summary of the progress and results achieved under the short-term objectives and activities for the 2021-2022 season. More detailed discussions followed below in Appendices and in the annual progress reports attached.

Table 1: A summary of the progress and results achieved under the short-term objectives and activities for the 2021-2022 season

KEY ACTIVITY	TIME-FRAME	OUTPUTS	SHORT-TERM OUTCOMES AND COMMENTS
Objective 1: To identify and select target regions, research locations and participants			
e) Use appropriate agro-ecological delineation as basis to select a specific target region(s) f) Identify and engage with active and interested farmer groups (volunteering, where there is a demand) as platform(s) for implementation g) Facilitate a participatory diagnosis (of problems, challenges, etc.) and planning process with farmer groups and other key stakeholders h) Identify research locations on specific farms and ecotopes for collaboratively-managed trials (CMTs) and farmer-managed trials (FMTs).	August to October 2021	<ul style="list-style-type: none"> • Planning workshops for Maluti and Mpum Highveld projects were held in August and September 2022. Farmer co-workers and sites were selected. • Annual Ottosdal planning workshop was held in September 2021. • Planning processes for smallholder projects in KZN were held in September to October 2021. 	<ul style="list-style-type: none"> • Good farmer co-workers, groups and trials sites were identified in all project study areas. • Scientific CMTs were designed including relevant treatments according to problems and issues identified by project teams, especially farmers.
Objective 2: To implement relevant on-farm trials according to need identified			
c) Prepare, establish and manage on-farm	October to November 2021	Designed and established the following CMTs:	All the CMTs were established successfully.

trials on selected sites (farms)		<ul style="list-style-type: none"> • Maluti: Marquard (x1), Clocolan(x1) • Mpum Highveld: Kinross (x2), Standerton (x1) • Ottosdal (x4) • KZN smallholders (x40) + 90 FMTs 	Farmer co-workers have been cooperating exceptionally well. A few challenges with some of the treatments were identified and solved, or improvements planned for the next season. The inclusion of organic and biological fertilisers is planned for 2022-23. See summary of projects implemented in <u>Appendix 1</u> below.
d) Implement and manage research activities through appropriate work packages around key research topics, questions and milestones	Continuous	<p>Four (4) key work packages have been used to implement and manage research activities around these trials. For commercial projects they are: Soil ecosystem health, Cover crops and livestock integration, Agronomy and Finances. Specific research questions and hypotheses are applicable to each work package.</p> <p>Four (4) year project cycles or milestones will be followed after which recommendations will be made to extend the research, or to terminate the project.</p>	In August 2022, ASSET Research synthesized recommendations of the CA evaluation panel on the CA FIP implementation and the outcomes of a Grain SA survey on CA. From that, amendments were proposed to the CA FIP funding application submitted in March 2022 that will constructively influence the research process going forward. See the Amendment attached in <u>Appendix 2</u> below.
Objective 3: To implement a monitoring and evaluation framework and process			
d) Participatory monitoring / data collection	January to June 2022	The main field work activity to collect soil samples and other parameters for Maluti and Mpum Highveld projects was in February 2022; Ottosdal collected soil samples in March and yield data only in September 2022;	Doing major field work actions, such as soil sampling, as a bigger team helped to reduce the load of a quite heavy task; involving students from NWU was also conducive to the productivity.

		KZN smallholder projects collected data from January right through to August.	
e) Farmer participatory M&E	January to June 2022	Completion of field monitoring with farmers, most especially with smallholder farmer in KZN. Using CA facilitators on various levels, as well as technical team members.	This is an important approach where joint monitoring activities form a key part of the project, such as the smallholder project in KZN.
f) Data analysis, evaluation and impact assessments	June to September 2022	Analysis of data collected from on-farm trials and monitoring points was done for each project. In some cases, such as Maluti and Mpum Highveld projects, specialist data management analyst was hired to assist. Economic analyses have become a core element of the CA FIP projects.	Analysis of data collected from on-farm trials and monitoring points is viewed as a critical step of all the projects. Large amounts of data are collected, which need to be well managed, analysed and interpreted. Care has been taken to address this adequately and a continuous effort to explore and interpret key indicators, such as soil health and profitability. A first attempt to assess the <u>impact</u> of the CA FIP has been made and discussed in Appendix 3 below .
Objective 3: To create wider awareness and innovation capacity in local farming communities on the practices and benefits of locally adapted CA systems.			
e) Annual farmers days or conferences	February to May 2022	Well organised and - attended awareness events were held in March and May 2022	Annual conferences (Reitz) and farmers days (Ottosdal, Bergville) were very successful. See a description of farmers days held in the 2021-2022 season in Appendix 4 below.
f) Communicate experiences and results	Continuous	Various articles, videos and presentations were made and/or published.	This activity has been successful in creating awareness and sharing information to key stakeholders, especially farmers. See Appendix 5 below for a list of some of the key publications. More can be seen on the ASSET research website (https://assetresearch.org)

			<u>.za/conservation-agriculture/</u>
g) Education and training	Continuous	Apart from project level training and learning activities, the CA FIP has increased its focus on a wider and higher level of training. A few initiatives have been targeted, namely: i) an online short course, ii) CA curriculum development at the Reitz Agricultural Academy and iii) tertiary training support at graduate and postgraduate level	The acute capacity problems and scarce skills in CA has increased the need for appropriate training initiatives in the country. Already, numerous requests for training could have been addressed to some extent by these initiatives. Further developments on this activity is currently underway. See Appendix 6 below for more detail on these initiatives.
h) Exposing on-farm trials to interested farmers and other	Continuous	Trial visits by interested people have been supported and primarily done by farmer trial co-workers on a needs-to-know basis.	An unknown number of interested people (mostly farmers) have been visiting the on-farm trials through the project cycle and had discussions with participating farmers and technical team members. Farmer trial co-workers has been instrumental in support of this activity.
Objective 4: To support communication, education, facilitation and reporting			
e) Project meetings for feedback and planning	July to September 2022	Major project meetings, especially with farmer co-workers, groups and staff were held to communicate, coordinate and plan various project activities, but especially trial treatments and practices.	A number of project meetings were held at each of the project sites to plan seasonal trials and other activities.
f) Farmer facilitation and coordination	Continuous	Frequent project meetings, especially with farmer co-workers, groups and staff were held to communicate, coordinate and plan various project activities, but especially trial treatments and practices. With the smallholder project in KZN, the effective deployment of	This essential process was successfully performed by key researchers in the ASSET Research project teams. On a programme level it was done by Dr Hendrik Smith who was assisted on project level by Dr Jaap Knot (Maluti and Mpum Highveld projects), Dr Andre Nel en Gerrie Trytsman (Ottosdal) and Ms

		project and local farmer facilitator were done to assist this process.	Erna Kruger (smallholders). Dr James Blignaut played an oversight role.
g) Stakeholder communication and involvement	Continuous	Several events were planned and/or attended. The key CA FIP event is the CA research forum to get feedback on the annual progress reports from the various projects.	Involving and influencing key CA stakeholders has been done successfully. See Appendix 7 below for a more detail description.
h) Reporting	March and September 2022	Six-monthly and annual reports were completed according to MT specifications	Completed bi-annual and annual reports are made available on the ASSET Research website. Annual reports for the 2021-22 season are attached in Appendix 8 to 10.

4. SUMMARY OF RESULTS

A first attempt to assess the impact of the CA FIP has been made and discussed in this report. These results show that the CA FIP have an exceptional positive impact on the a) immediate sphere of control and influence (direct impact or 'footprint') through project activities, b) indirect sphere of influence (wider impact or footprint) through awareness events, and c) growth in CA adoption.

Various articles, videos and presentations were made and/or published and are all available on the ASSET Research website.

Four on-farm research projects were continued and are running smoothly at this stage: three commercial projects (Ottosdal, Maluti and Mpumalanga) and one smallholder project (KwaZulu-Natal). At this stage, these projects have shown acceptable success, progress and impact with expected milestones being achieved.

A sustainability performance scoring system has been developed, combining key indicators measured on twenty-four (24) treatments of three production systems (CT, NT & CA) on five (5) on-farm trials over two years in the Maluti and Mpumalanga Highveld study areas. The aim was to compare how different systems are performing overall. The indicators used were profitability (yields, and net margins ha⁻¹), plant quality (Brix), and resource use efficiency (rainfall use efficiency measured in total biomass and N efficiency). A weight % was given to each indicator based on their importance in terms of sustainability and a score (1 to 3) was awarded according to each indicator's performance and multiplied with the weight. This was not a statistical analysis, but it is work in progress towards an overall score or index showing how different systems compare using multiple and related indicators.

Scoring system comparing different production systems

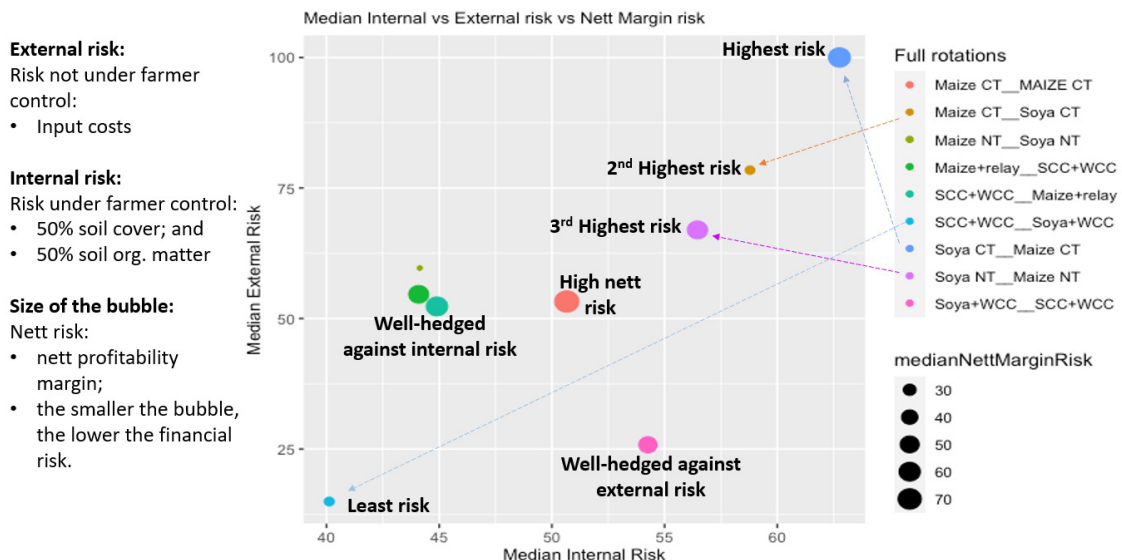
Description	Weight	Maize			Soya		
		RA/CA	NT	CT	RA/CA	NT	CT
Yield	7.5%	0.38	0.83	0.83	0.68	0.38	0.30
Brix	7.5%	2.40	2.70	3.83	2.78	2.03	2.25
WUE of total biomass	15%	1.95	2.55	2.55	2.70	2.40	2.25
N efficiency - Maize	20%	2.40	3.40	3.80			
Net margins for 2021/22 season	50%	5.50	6.00	3.50	5.50	5.00	1.50
TOTAL SCORE	100%	12.63	15.48	14.50	11.65	9.80	6.30

Comparing production systems purely on profitability, other aspects like soil health, grain quality, and risk (water use efficiency/ synthetic input costs and build-up of soil ecosystem health) are ignored. In addition, comparing systems using yields only is a conservative snapshot in time. The profitability of the systems is of paramount importance, whilst improved grain quality (and plant vigour), WUE, total production and potential build-up of SOC and reduction of synthetic inputs, are all important.

From the table above, the net margin scoring for maize (2021/22 season) was the highest under NT, followed closely by CA/RA and consequently least under CT. For Soya, the scoring system shows a similar picture with CA/RA the highest net margins, followed marginally by NT and CT again the lowest score. In other words, the least profitable system for maize and soya is CT despite having highest yields and Brix for maize.

The total combined score for maize shows that NT was the highest, followed by CT and then CA. For soya the highest was CA, followed by NT and then CT. The main drawback of this approach is that it negates the benefits gained by the crop rotational effects in combination with the integration of livestock using cover crops. By focussing on a crop-based analysis it is plausible that the wrong assessments can be made. It is of paramount importance to consider a system-wide approach over time. Such an analysis has subsequently been done.

Based on the same dataset for the Maluti and Mpumalanga Highveld trials, the results of an integrated assessment considering the system-wide impacts over two rotations are shown in the figure below. This shows that the system with the highest risk is conventional tillage (CT) soya



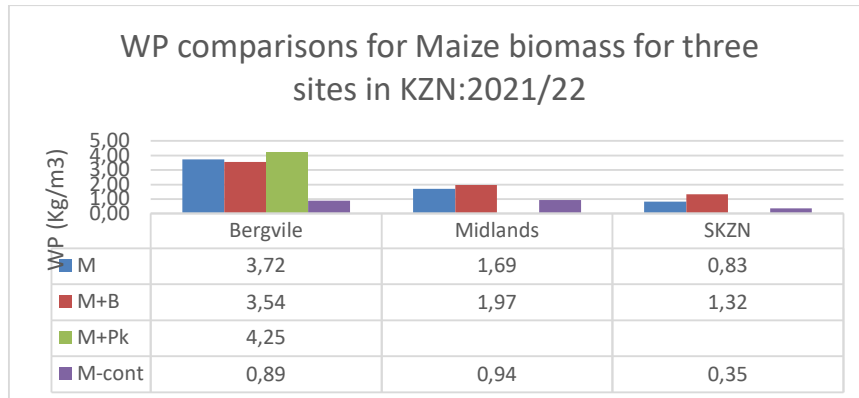
and maize rotation, while the system with the least risk is the CA double cover crop with soya and winter cover crop rotation. This risk assessment has been conducted in the following manner:

- External risk: vulnerability to external price shocks:
 - The cost of external inputs of all the trail plots have been indexed relative to the rotation with the highest cost (or most expensive), which has been given a score of 100.
- Internal risk: vulnerability to system resilience based on land management:
 - The respective soil organic matter and soil cover scores of all the rotations and trails have been indexed with each contributing 50% to a final composite score and expressed relative to the lowest score (or worst), with the lowest being 100.
- Nett profit margin risk:
 - The difference between turnover and total cost has been calculated for all rotations and trials and all nett values have been expressed relative to the lowest (or worst) value. In the figure above that is represented by the large bullets, the larger the bullet the lower the profitability.

In the smallholder CA research project, runoff measurements averages across all CA trial plots (with maize-bean intercropping) were almost 30-50% lower than runoff in the control plots (CA control maize-mono cropped), implying much less soil erosion and much more water in the soil (i.e. 694 000 L/ha per year more water in the soil and available to crops). Yield advantages for maize through intercropping and crop rotation are evident after a continuous CA implementation cycle of 4 or more years: average yields measured on the research trials were: maize-intercrop - 5,22t/ha, maize-monocrop - 4,18 t/ha, and maize-control - 2,87t/ha.

Maximum yields have increased from 6,7 t/ha to 13,6 t/ha between 2014 and 2021, for high performing CA smallholder farmers. A yield gain of ~1 t/ha per annum is possible under CA cropping systems despite difficult climatic conditions.

The crop water productivity (CWP), or water use efficiency (WUE) was also calculated for the above-ground maize biomass (Dry Matter in kg/m³) (stalks and leaves) on smallholder CMTs as shown below.



CWP comparisons for maize biomass for three sites in KZN: 2021/22

The need for support and advice among farmers to implement and adapt CA in their unique realities (contexts) is creating a serious need for people with the appropriate skills and capacity. In that respect the CA FIP and ASSET Research have been involved in the following capacity

building initiatives: i) an online short course in CA, ii) CA curriculum development at the Reitz Agricultural Academy, and iii) tertiary training support at graduate and postgraduate level.

5. PLANNED RESEARCH: 2022-23

In August 2022, ASSET Research synthesized recommendations of the CA evaluation panel on the CA FIP implementation and the outcomes of a Grain SA survey on CA. From that, amendments were proposed to the CA FIP funding application submitted to The Maize Trust in March 2022.

The amendments submitted to The MT in September 2022 relate to the planned research for the 2022-2023 season and will have a constructive and positive change on the following aspects of the CA FIP projects: i) the implementation and management of the work packages, ii) monitoring and termination of the projects, and iii) analysing the relative profitability of the various production systems. These amendments are applicable to the existing and new CA projects and will be followed from the 2023-24 season. See Appendix 2 below for research questions and hypotheses to be addressed in commercial (2A) and smallholder (2B) projects.

APPENDIX 1: SUMMARY OF PROGRESS AND RESULTS OF RESEARCH PROJECTS

The Maize Trust funded several CA research projects for the 2020/21 crop season and has requested the CA facilitator at ASSET Research to assist with the evaluation and re-alignment of these projects under the CA FIP philosophy. A panel of CA experts was established to assist with the evaluation of new CA project proposals and progress/final reports. The panel has successfully assisted the MT with an evaluation of the 2021–2022 applications and reports.

These CA FIP projects advocate The Maize Trust’s strategy on CA and strictly follow an on-farm systems research approach, whereby farmers are actively involved in experiments on their farms, of which the main collaboratively managed trials (CMTs) are statistically designed and well supported by researchers. These trials focus on practices (treatments) such as crop rotations, crop density, cover crops and livestock integration. Various key aspects are investigated, in particular soil health, productivity, crop quality and profitability, and various stakeholders have been involved to take up these responsibilities. The farmer-managed (FM) or baby-trials refer to experiments/practices where farmers test CA treatments (ideally taken from the mother-trials) in their own contexts or realities; the more farmers involved with CA ‘experimentation’, the better for wider scale implementation and adaptation. Some baby-trials were previously monitored at the Vrede and Reitz study areas, as well as with the smallholder projects under MDF, and results were documented in the annual progress reports.

The prime objectives of these participatory systems research projects are to research and develop sustainable and profitable CA systems in a range of local farming contexts, by working with and empowering farmers to adopt and adapt CA in their own realities. In this process, relevant research questions on all aspects of the CA approach and technologies, have been developed for each of the various work packages (which were included in the amendment submitted in September 2022). In smallholder systems, this process is more complex and critical and CMTs have been established with smallholder groups which are linked to the development of institutional, infrastructure, social and economic components of the system, including the value chain.

For the 2021-2022 season, five MT-funded research projects, which are hosted under the banner of the CA FIP at ASSET Research, were implemented in different study areas. In the North West Province, a project investigates commercial CA practices under semi-arid, sandy soil conditions with the Ottosdal No-till Club, while the CA smallholder project focusses on *adaptive quantitative CA research* in KwaZulu-Natal and started in October 2020. Two projects were initiated in the 2019/2020 season to research CA in two commercial farming study areas in the Maluti region of the Eastern Free State and the Mpumalanga Highveld. A short summary of these projects follows below.

CA smallholder project

The smallholder project on *adaptive quantitative CA research* in KwaZulu-Natal started in October 2020. A selection of the participants now participates in an on-farm experimentation process actively involved with collaboratively managed trials (CMTs). In these CMTs farmers and researchers work together on problem definition, design, management and implementation of statistically sound trials as well as evaluation. Forty (40) CMTs have been implemented with

participants across the Bergville, SKZN and Midlands sites. They are managed alongside the farmer level experimentation or “baby” trials, of which there have been 90 this season.

In the smallholder CA research project, average runoff measurement results across all CA plots (with maize-bean intercropping) were almost 30-50% lower than runoff in the control plots (CA control maize-mono cropped), implying much less soil erosion and much more water in the soil (i.e. 694 000 L/ha per year more water in the soil and available to crops). Yield advantages for maize through intercropping and crop rotation are evident after a continuous CA implementation cycle of 4 or more years: average yields measured on the research trials were: maize-intercrop - 5,22t/ha, maize-monocrop - 4,18 t/ha, and maize-control - 2,87t/ha.

Maximum yields have increased from 6,7 t/ha to 13,6 t/ha between 2014 and 2021, for high performing CA smallholder farmers. A yield gain of ~1 t/ha per annum is possible under CA cropping systems despite difficult climatic conditions.



A smallholder trial site in Bergville, KwaZulu-Natal

Commercial farmer CA projects

The CA project in the North West Province started with its eighth season in collaboration with the Ottosdal No-till Club. More than 90 on-farm collaborative-managed (CMTs or mother-trials) (farmer-researcher) have so far been implemented in this project producing valuable results for this region. Two farm locations have been used to implement a range of trials in the 2020–2021 season, namely Korannafontein (Hannes Otto) and Humanskraal (George Steyn). See photo of the trial site at Korannafontein below.



Ottosdal trial at Korannafontein

Two new participatory systems research projects on CA for commercial farmers in the Maluti (eastern Free State) and the Mpumalanga Highveld regions have completed their second season; both projects successfully started in October 2020 and a total of five (5) major on-farm mother-trials were implemented on a representative, important ecotopes in the following areas: Marquard and Ficksburg (Maluti), Standerton and Secunda (×2) (Mpumalanga Highveld) (see drone photos of the trials at Standerton and Kinross (New farm) below). For the 2021–2022 season, the Ficksburg trial was moved to Clocolan due to unforeseen financial problems experienced by the farmer in Ficksburg.

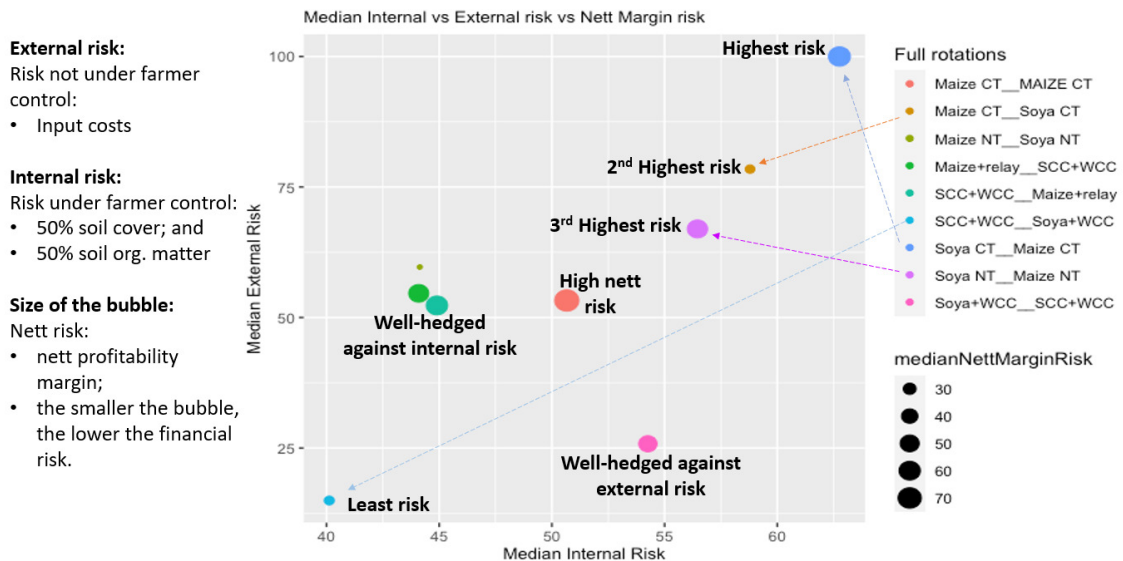


Standerton trial site



Kinross, New Farm trial site

The outcome of a risk analysis using data from twenty-four (24) treatments of three production systems (CT, NT & CA) on four (4) on-farm trials over two years in the Maluti and Mpumalanga Highveld projects are shown below. This shows that the system with the highest risk is conventional tillage (CT) soya and maize rotation, while the system with the least risk is the CA



double cover crop with soya and winter cover crop rotation. This risk assessment has been conducted in the following manner:

- External risk: vulnerability to external price shocks:
 - The cost of external inputs of all the trail plots have been indexed relative to the rotation with the highest cost (or most expensive), which has been given a score of 100.
- Internal risk: vulnerability to system resilience based on land management:

- The respective soil organic matter and soil cover scores of all the rotations and trails have been indexed with each contributing 50% to a final composite score and expressed relative to the lowest score (or worst), with the lowest being 100.
- Nett profit margin risk:
 - The difference between turnover and total cost has been calculated for all rotations and trials and all nett values have been expressed relative to the lowest (or worst) value. In the figure above that is represented by the large bullets, the larger the bullet the lower the profitability.

The detailed results described in the annual progress reports show that significant progress and impact have been made in all these projects, which imply that CA crop production systems (in both commercial and smallholder situations) are being successfully tested and adapted through a collaborative effort (farmers and researchers) and by local farmers in their own realities, which are mostly farmers who were exposed to these project activities through awareness events and publications. However, amidst the various serious environmental threats and dire economic situation of many grain farmers, a greater urgency emerged to adapt CA with more farmers much faster. **Separate progress reports for these four projects are attached in Appendix 9 to 11**, with the Maluti and Mpumalanga Highveld reports combined in one. After the evaluation process, these reports will also be made available on the ASSET Research website at <https://assetresearch.org.za/>.

APPENDIX 2: RESEARCH QUESTIONS AND HYPOTHESES TO BE ADDRESSED IN COMMERCIAL (2A) AND SMALLHOLDER (2B) PROJECTS

Appendix 2A: Research questions and hypotheses for each cross-cutting project work package for commercial farmers:

Work package	Initial phase: 2020/21 – 2023/24 (4 years, of which two are completed)	Transition phase: 2024/25-2027/28 (5-8 years - future research)
Soil ecosystem health	<p>Research question 1: Does implementing CA increase soil health and fertility across multiple project ecotopes (trial sites) in the various grain regions in this period?</p> <p>Hypothesis 1: It is hypothesised that the soil health and fertility status of CA treatments will start to improve soil ecosystems in this period (i.e., increase active carbon and re-establish microbial biomass and activity, start improving organic N levels and availability) and that the CA systems will already provide the greatest soil health benefits with significant variation between different systems and project ecotopes (trials).</p> <p>Research question 2: Can nematode-based indices be used to study and predict changes in soil ecosystem health and functioning in croplands under different agricultural management practices and environmental conditions?</p> <p>Hypothesis 2: Nematode-based indices represent a reliable toolset for measuring the soil ecosystem health and functioning status of croplands under different agricultural management practices and environmental conditions.</p>	<p>Research question 1: Does implementing CA increase soil health and fertility across multiple project ecotopes (trial sites) in the various grain regions in this period?</p> <p>Hypothesis 1: It is hypothesised that the soil health and fertility status of CA treatments will significantly improve in this period (i.e., increasing SOM, increasing organic N, P and K availability, resulting in the further decrease of fertilizer use; rebuilding of soil aggregates will be evident) and that the CA systems will provide the greatest soil health benefits with significant variation between different local systems and project ecotopes.</p> <p>Research question 2: Can nematode-based indices be used to study and predict changes in soil ecosystem health and functioning in croplands under different agricultural management practices and environmental conditions?</p> <p>Hypothesis 2: Nematode-based indices represent a reliable toolset for measuring the soil ecosystem health and functioning status of croplands under different agricultural management practices and environmental conditions.</p>
Cover crops and livestock integration	<p>Research question 1: What is the contribution of cover crops and meat production to crop-livestock farming systems in this period?</p> <p>Hypothesis 1: Cover crops and livestock CA practices will start to diversify and increase total production (double cropping and income; cash crops and livestock).</p> <p>Research question 2: What is the impact of cover crops and livestock integration on soil health and biodiversity and the use of external inputs, especially agro-chemicals?</p> <p>Hypothesis 2: Cover crops and livestock CA practices will start to positively affect soil health (see previous work package), biodiversity (e.g., increase in dung beetle activity and pollinators) and the use of</p>	<p>Research question 1: What is the contribution of cover crops and meat production to crop-livestock farming systems in this period?</p> <p>Hypothesis 1: Cover crops and livestock CA practices will reach much higher diverse total production (through double cropping and income; cash crops and livestock).</p> <p>Research question 2: What is the impact of cover crops and livestock integration on soil health and biodiversity and the use of external inputs, especially agro-chemicals?</p> <p>Hypothesis 2: Cover crops and livestock CA practices will accelerate soil health (see previous work package), biodiversity (e.g., increase in dung beetle activity and pollinators) and the</p>

	<p>external inputs, especially agro-chemicals.</p> <p>Research question 3: What is the impact of cover crops and livestock integration on production and profitability (biomass, grain, meat)?</p> <p>Hypothesis 3: Cover crops and livestock CA practices will start to diversify and increase production and income streams, as well as profitability.</p>	<p>decrease of external inputs, especially agro-chemicals.</p> <p>Research question 3: What is the impact of cover crops and livestock integration on production and profitability (biomass, grain, meat)?</p> <p>Hypothesis 3: Cover crops and livestock CA practices will significantly diversify and increase production and income streams, as well as profitability.</p>
Agronomy	<p>Research question 1: Will CA improve cash crop productivity, quality, efficiency and resilience compared to local CT and NT in this period?</p> <p>Hypothesis 1: CA systems will introduce and implement sound cash crop rotations, and start increasing crop residue and soil organic cover, as well a water / nutrient use efficiency. Slight decreases in yields might be expected in some contexts due to poor soil condition and/or challenges to adapt CA correctly, e.g., in weed management.</p>	<p>Research question 1: Will CA improve cash crop productivity, quality, efficiency and resilience compared to local CT and NT in this period?</p> <p>Hypothesis 1: CA systems will optimise cash crop rotations (e.g., rotating with cover crops and livestock), and will reach much higher levels of crop residue and soil organic cover, as well a water / nutrient use efficiency. No decreases in yields, but instead slight, stable increases are expected, especially in dry / extreme seasons (i.e., improved resilience). Grain and crop quality under CA systems will be better than other local systems.</p>
Finances	<p>Research question 1: Does CA implementation reduce the production cost and improve profitability?</p> <p>Hypothesis 1: CA does reduce the production cost and increase the profitability of the operations.</p> <p>Research question 2: Does the integration of livestock improve the profitability of the operation?</p> <p>Hypothesis 2: Livestock integration does improve the profitability of the operation.</p>	<p>Research question 1: What are the relative cost differentials, measured in terms of R/ha/ton yield, inclusive of livestock returns, among the various production systems.</p> <p>Hypothesis 1: The R/ha/ton yield of CA is higher than that of the comparative systems.</p> <p>Research question 2: Does the long-term returns of CA outweigh its initial costs?</p> <p>Hypothesis 2: The long-run returns of CA does outweigh its initial costs.</p>
Project milestones		
	<p>Interim milestones are the project reports as per the conventional funding and application cycle of the MT. Final report in September 2024 to provide answers to the research questions listed above. Recommendations will be made to extend the research or to terminate project.</p>	<p>Interim milestones are the project reports as per the conventional funding and application cycle of the MT. Final report in September 2028 to provide answers to the research questions listed above. Recommendations will be made to extend or terminate project.</p>

Appendix 2B: Research questions and hypotheses for smallholder CA adaptive research

The overall research question for the smallholder research process is: How will the use of CA improve the production, productivity, environmental and economic sustainability of dryland maize production for smallholder farmers, by focusing on appropriate, adapted CA farming systems within a local socio-ecological context, using an innovation systems approach?

Two sub-groups of smallholders

There are two sub-groups for whom assumptions and hypotheses will differ slightly, given that MDF has been working with several farmers to implement CA for some years already. Farmers new to CA need a different research emphasis:

Smallholders new to CA: 2020/21 – 2022/23 (3 years of which 2 have been completed)	Smallholders developing an integrated CA system 2022/23-2025/26 (4-8 years, future research)	Smallholders developing a sustainable, resilient CA system 2022/23-2029/30 (4-12 years, future research)
<p>Research question 1: How will CA impact the livelihood and profitability of smallholders new to CA in this period?</p> <p>Hypothesis 1: CA systems will start to diversify and increase total production (increased maize and legume yields, increased availability of livestock fodder), start increasing crop residue and soil organic cover, start to improve soil ecosystems (i.e. increase active carbon and re-establish microbial biomass and activity, start improving organic N levels and availability) and start to improve water management aspects (decreased runoff, improved infiltration, increased water holding capacity)</p> <p>The assumption is that CA will provide for an immediate reduction in input and management costs and show an overall reduction in labour requirements. Participants will become familiar with use of CA practices and implements and start to make arrangements for local access and availability of equipment and inputs.</p>	<p>Research question 2: How will an integrated CA systems impact the livelihood and profitability smallholders in this period?</p> <p>Hypothesis 2: CA systems will diversify and increase total production (increased maize and legume yields, increased availability of livestock fodder), increase crop residue and soil organic cover, and soil ecosystems functioning under CA systems will accelerate (i.e. increasing SOM, start increasing organic N, P and K (fertility), reduce compaction and rebuilding of soil aggregates); water management aspects will significantly improve (decreased runoff, improved infiltration, increased water holding capacity). Practices for integration of livestock become more of a focus.</p> <p>The assumption is that farmers will organize themselves to have access and availability of inputs and equipment and start to consider storage and local marketing options. Farmers will fully master CA practices and implements. They will arrange for local savings and small loan associations to assist in economic sustainability and affordability of inputs and they will improve the social agency of the farmers groups to manage these systems.</p>	<p>Research question 3: How will sustainable, resilient CA systems impact the livelihood and profitability smallholders in this period?</p> <p>Hypothesis 3: CA systems will diversify and stabilize total production in the context of climate change and weather variability (increased use of suitable and diverse varieties of field crops and increased production of a variety of livestock fodder species), continue to increase and stabilize crop residue and soil organic cover, soil ecosystems functioning under CA systems will stabilize (incl., SOM, organic N, P and K (fertility), reduced compaction and improved soil aggregates). Quantifiable improvements in water management aspects are possible (decreased runoff, increased water holding capacity). Expansion of livestock integration practice and quantifiable improvements in fodder quantity and quality.</p> <p>The assumption is that farmers will strengthen their local financial, marketing and collaboration to increase their economic sustainability and will work on the appropriate governance structures in their communities to manage the expanded production and livestock integration aspects. Farmers will fully adapt CA practices and implements in their local contexts.</p>
Milestones		
<p>Interim milestones are the project reports as per the conventional funding and application cycle of the MT.</p> <p>Final report in September 2023 to provide answers to the research questions listed above.</p> <p>Recommendations will be made to extend the research or to terminate project.</p>	<p>Interim milestones are the project reports as per the conventional funding and application cycle of the MT.</p> <p>Final report in September 2026 to provide answers to the research questions listed above.</p> <p>Recommendations will be made to extend the research or to terminate project.</p>	<p>Interim milestones are the project reports as per the conventional funding and application cycle of the MT.</p> <p>Final report in September 2030 to provide answers to the research questions listed above.</p> <p>Recommendations will be made to extend the research or to terminate project.</p>

APPENDIX 3: IMPACT OF THE CA FIP

One of the key activities of the CA FIP is to evaluate its impact. A rapid impact assessment was carried out using the following three indicators: a) Immediate sphere of control and influence (Direct Impact or 'footprint') through project activities, b) Indirect sphere of influence (wider impact or footprint) through awareness events, and c) return on investment (RoI).

Table 1 shows the number of different role players directly involved with project activities, as well as the accumulated number of people by March 2022. The accumulated number of people is 186, and the following can be concluded:

- Conventional (linear) research programmes focus mainly on Col #1 to #3.
- ASSET Research is a capacity building NGO/PBO and emphasises it in its approach.
- This farmer-centred innovation systems approach actively involves farmers, which increases empowerment, capacity development, farmer buy-in and ownership; farmers are also making in-kind contributions, such as implements, inputs, land, time, etc..
- A high number of people is involved in the FIP programme given its design.
- It therefore has an impact and influence on a broad range of key stakeholders.
- It has a high social and human capital impact and sustainability.
- It facilitates the adoption of CA and provides good value for money.

Table 1: Immediate sphere of control and influence (Direct Impact or 'footprint') through project activities

Current CA FIP Projects	Project lead	Resear- chers	Lab & tech assistants & interns	Farmers	Project & farmer facilitators	Farm workers	Trial area (ha)
Maluti & Mpum	1	3	7	8	0	7	25
Ottosdal	1	3	7	5	1	4	20
Smallholders	1	3	7	112	16	0	43
Total	3	9	21	125	17	11	88
Accum # people	3	12	33	158	175	186	

Table 2 shows the indirect sphere of influence (wider impact or footprint) through awareness events. In monetary value, the indirect sphere of influence over a period of 3 years amounts to more than R11 billion. The following are concluded from this assessment:

- This assessment only measures the impact of awareness events (i.e., the farmers days). None of the other strategies part of the CA FIP are included, such as publications, social media, videos, students, internships, etc.
- The 'influence' on farmers behaviour is difficult to measure. However, based on the CA adoption survey done in 2021 (FAO, 2021), there has been a high adoption of CA in the last decade in the maize production regions, especially the North West, Mpumalanga and Gauteng Provinces.
- The massive value of R11 billion (the turnover of maize production exposed to the CA FIP) has been impacted by less than R5 million funding. This shows that the funds have been used effectively and efficiently - the right things are done right.

Table 2: Indirect sphere of influence (wider impact or footprint) through awareness events

Projects	*Attendees 2020	Attendees 2021	Attendees 2022
Reitz	covid	covid	300
Maluti & Mpum	0	200	planned
Ottosdal	100	100	200
Total commercial farmers	100	300	500
Total ha (600 ha per farmer)	60000	180000	300000
Total Smallholders	200	200	200
Total ha (1 ha per farmer)	200	200	200
Total area (ha)	60200	180200	300200
Avg yield of maize (t/ha)	6	6	6
Price for maize (R/t)	3400	3400	3400
Total revenue (R)	1 228 080 000	3 676 080 000	6 124 080 000
Grand total for 3 years (R)			11 028 240 000

*not all attendees were farmers, so the # was reduced

For the third indicator, the growth in CA adoption has been used. Table 3 below show that there has been an 8% growth in CA adoption per year. This fairly sharp growth requires a continuous effort to support new CA adopters through research, extension and financial analyses, advice and incentive mechanisms. The presence of an initiative like the CA FIP are considered a high priority to serve the above needs.

Table 3: Recent growth in CA in South Africa's summer rainfall area

	2013	2021
Croplands in South Africa (ha)	6 330 910	
Total area under CA (ha, excl. WC)	439 000	802 215*
CA as % of total croplands	7%	13%
CA growth (ha)		363 215
CA growth % per year over 8 years		8%

* (from FAO, 2021)

APPENDIX 4: CA AWARENESS RAISING EVENTS

General awareness (or sensitisation) has been experienced as particularly important to stimulate farmers to get involved with further learning and implementation activities, such as study groups, experimentation / testing and field days. The whole CA Farmer Innovation Process needs this 'impulse' or injection of motivation and inspiration (interest or motivation) to start or to speed up the momentum and specific awareness or sensitisation events are employed in this regard. The following events took place since October 2021:

Commercial farmers' awareness events

On 7 and 8 March the Regenerative agriculture conference took place in Reitz displaying well selected speakers and field demonstrations to around 350 participants. The farmers' day in Ottosdal took place on 10 March 2022 in collaboration with *Landbouweekblad* and various partners and sponsors. Around 250 people attended the event. The day kicked-off with four oral presentations in the show grounds hall, whereafter the participants departed to the main trials site on the farm Humanslaagte, where various presenters discussed relevant topics at three field sites. Photos below were taken during the various commercial farmers days.



Photos 1 and 2: *Left:* Participants observing a soil profile pit at the Reitz conference. *Right:* About 350 people attended the Reitz conference on 7&8 March.



Photos 3 and 4: *Left:* Overseas presenters Mr Pablo Etcheberry (Argentina), Dr Ademir Calegari (Brazil) with Mr Gerrie Trytsman (ASSET Research) talking to participants. *Right:* Mr Trytsman and Dr Calegari standing at the sunflower intercropping trial, at the Ottosdal farmers day on 10 March.



Photos 5 and 6: *Left:* The late Mr Hannes Otto, founder of the Ottosdal No-till Club, speaking to participants, *Right:* A farmers discussion was facilitated at one point in the field at the farmers day on 10 March 2022.

On 10 and 12 May 2022 two farmers days were held in the Maluti (eastern Free State) and Mpumalanga Highveld study areas respectively. In Maluti about 50 people attend the day at the Imla farm in Clocolan, where one of the CA trials has been implemented. In Mpumalanga Highveld about 50 people attended the day at the Tarentaalbos venue in Kinross, where one of the CA trials has been implemented.



Photos 7 and 8: *Left:* Participants at Imla, Maluti region listen to presentations, *Right:* Danie Bester, a CA farmer from Balfour in Mpumalanga presented at both days.



Photos 9 to 11: Speakers at the Imla farmers day: Mary Maluleke (ASSET Research), Jan Groenewald and Hans van Rooyen (both farmers in Clocolan area)



Photos 12 and 13: Left: Participants at the Kinross farmers day, Mpumalanga region visit the trial, Right: Hendrik Odendaal, a CA farmer from Standerton in Mpumalanga presented at the trial site.



Photos 14 and 15: Left: Members from the Department of Agriculture (Adolph Malatji, Lydia Bosogo and Keamogetsi Mudzielwana) with Nicol de Vos (Kinross) at the Kinross farmers day, Mpumalanga region, Right: Participants have discussions at the Kinross farmers day in Mpumalanga.

Smallholder farmers' awareness events

A range of awareness raising and stakeholder involvement activities were launched within the CA smallholder project during the 2021-2022 season:

- Farmer's open days (see below)
- uThukela catchment partnership
- District Development Agency (Bergville)
- Farming for Climate Justice research (Midlands)
- CEDARA: RRM students learning visit
- Community level cross visits

Farmer's day

On 2 March 2022 a CA farmers day for smallholders was held in the Emmaus study area, Bergville district, KwaZulu-Natal. The event was attended by around 200 people, mostly smallholders, and consisted of talks and presentations by leading implementers in CA and smallholder farmers as well as visits to farmers fields to view CA in action.

Topics discussed include:

- CA in smallholder farming systems – progress over the last 5 years
- CA in commercial farming systems – a talk by Mark Stewart, Zunckle's farming
- Livestock integration and
- Crop diversification and soil health



Photos 7 and 8: *Left:* Mark Stewart from Zunkels' farming in Warden Free State, did a presentation on the CA systems in commercial farming. *Right:* Mark in discussion with local farmers at their fields.



Photos 9 and 10: *Left:* About 200 people attended the farmers day at Emmaus in Bergville. *Right:* The local farmers honoured Erna Kruger from Mahlathini Development Foundation with a special blanket for the decades of service she has been doing for these rural communities.



Photos 11 and 12: *Left:* Participants visited the CA trial of Mrs Nombono Dladla. *Right:* Different treatments of cash crops, intercropping and cover crops were demonstrated on the CA trial.

APPENDIX 5: KEY PUBLICATIONS, VIDEOS AND PRESENTATIONS

Various articles have been published in popular magazines, such as *SA Grain/Graan*, *Landbouweekblad*, *Farmers Weekly*, *African Farming* and *ReStory* newsletter. The published articles on CA can be accessed on the website of ASSET Research (<https://assetresearch.org.za/>). A range of different institutions (e.g. the ARC and universities) are also publishing increasing numbers of articles on CA in *SA Grain* and other journals/magazines, such as *Farmers Weekly* and *Landbouweekblad*. Many of these articles flow from the CA FIP projects, which have been generating a wealth of very appropriate information for producers and other practitioners. Several peer-reviewed articles and book chapters on CA FIP results have also been published in the last couple of years; below are some of the key publications:

- Truter, W., Dannhauser, C., Smith, H.J. and Trytsman, G. 2017. Conservation agriculture: Integrated crop and pasture-based livestock production systems. Article series, *SA Grain* magazine. [<https://www.grainsa.co.za/sa-graan-grain-article-series/conservation-agriculture>]
- Haarhoff, S.J. and Swanepoel, P.A. 2020. Narrow rows and a high maize plant population improve water use and grain yield under conservation agriculture. *Agronomy Journal* 112, 921–931.
- Haarhoff, S.J. and Swanepoel, P.A. 2020. Geil mielieplante te danke aan sterk wortelgroei. *Arena* Mei/Junie, 29–32.
- Smith, H.J., Kruger, E., Knot, J. and Blignaut, J.N. 2017. Chapter 12: Conservation Agriculture in South Africa: lessons from case studies. In Kassam, A., Mkomwa, S. and Friedrich, T. (eds). *Conservation agriculture for Africa: building resilient farming systems in a changing climate*. Wallingford: CAB International.
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- James Blignaut, 2022. Herstruktureer skuld so. *SA Graan*.
- Groter kans vir sukses met 'n deklaag. *SA Graan*, April 2022, P 39-41.
- Dié ernstige skade kan voorkom word. *SA Graan*, July 2022, P 86-88.
- An electronic booklet consisting of 15 published articles from the Ottosdal CA project was compiled and is available on the ASSET Research website (see website https://assetresearch.org.za/ottosdal-artikelreeks-boekie_web/).

APPENDIX 6: EDUCATION AND TRAINING

One of the key strategic objectives of the FIP, is CA education and training, which has three focus areas: a) school curriculum development, b) tertiary training at graduate and postgraduate level, and c) training events and processes integrated with the project innovation process. The third is reported on in the project reports, while the following feedback is on the first two focus areas:

- **School curriculum development:** The CA FIP, with financial support from the Sasol Trust, VKB, John Deere and Standard bank, is involved with the CA curriculum development at the Reitz Agricultural Academy, linked to the Reitz High School. Ms Rihana Botha (curriculum development specialist), supported by Dr Smith has been contracted to develop a CA curriculum for Grade 10, 11 and 12 during 2019 and 2020. Parallel to that, a curriculum is developed on precision agriculture. The academy opened its doors on 22 January 2020 and started the CA training for Grade 10s.
- **Tertiary training at graduate and postgraduate level:** Several Masters' and PhD studies have been done in the different on-farm innovation platforms (or projects) as part of the FIP. At the moment the following students and interns from the North West University have registered their studies on the CA FIP study sites:
 - **Mr Justin Brittion** (MSc) works on the Maluti & Mpumalaga Highveld projects with the title: *Soil health status and soil fertility of conservation and regenerative agriculture systems across multiple ecotopes*
 - **Mrs Nikatil Azizah** (MSc) works on the Ottosdal project with the title: *Soil food web status as an indicator of ecosystem recovery in crop production systems*
 - **Mrs Ane Loggenberg** received her MSc at NWU in 2021 (cum lauda) on the Reitz and Vrede study sites with the title: *Measuring ecological restoration in conservation agricultural fields in the eastern Free State (South Africa) using nematodes and other soil bioindicators.*
 - **Mrs Mary Maluleke** (MSc at Rhodes) has been appointed by ASSET Research as an intern to do financial modelling assessments on data collected in the current CA projects.
 - **Mrs Liane Erasmus** (BSc Agric at UFS) has been appointed by ASSET Research as an intern to develop capacity in the field of CA, specifically crop and livestock integration.
- **Conservation agriculture short course:** A framework and content for this short course was developed by ASSET Research and is available on their website (<https://assetresearch.org.za/ca-short-course/>) as a free online source. It can also be implemented as face-to-face course with appropriate presenters in each slot. The basic course framework looks as follows:

1. Introduction to the farm as an eco-business

- 1.1 'Leaks' on the farm that influence your profitability
- 1.2 Basic introduction to farm economics
- 1.3 The paradigm of regeneration

- 2. Introduction to ecosystems (capital), ecosystems functions (process) and ecoservices (flows or returns)**
 - 2.1 Farm with nature
 - 2.2 Basic introduction to farm ecology
 - 2.3 Plant-soil-water-economy relationship (by eco-type)
- 3. Introduction to CA/RA production system for different branches and regions (1)**
 - 3.1 Basic intro to CA principles
 - 3.2 Evidence-based outcomes
- 4. Introduction to CA/RA production system for different branches and regions (2)**
 - 4.1 Basic intro to CA practices
 - 4.2 In South Africa and international case studies and experiences
- 5. Assessing on-farm impact and progress of CA/RA implementation**
 - 5.1 Various bio-physical, social and economic measurement, indicators of progress.
- 6. From theory to practice**
 - 6.1 Steps of adaptation and implementation of on-farm CA/RA. What must you do?
 - 6.2 Monitoring your progress and change.
- 7. Value chain / Global context**
 - 7.1 Value chain analysis by branch and changing the place of entry into the value chain
 - 7.2 Farmer innovations
- 8. Life after the CA/RA course (networks, mentorships)**
 - 8.1 Mentorship, periodic feedback, networks and scaling

APPENDIX 7: STAKEHOLDER COMMUNICATION AND INVOLVEMENT

Annual CA research forum

A range of stakeholders has been engaged with as part of a national and international stakeholder network. One of the major initiatives was the development of a CA research forum aiming to reach a much wider stakeholder network in sharing and evaluating current CA FIP project results. The previous CA research forum meeting was held at the ARC Small Grain in Bethlehem on 12 October 2021 after it was interrupted for a long period by the Covid-19 pandemic. This seasons' forum took place on 27 September 2022 at Farmhouse58, Muldersdrift and was chaired by Mr Cobus van Coller, CA farmer from Viljoenskroon (see the meeting's agenda below). Fifteen people attended physically and fourteen people online (see photos below). Apart from having feedback and discussions on the CA FIP project reports, various other related projects and initiatives have been invited as part of a wider network of CA research and development partners. On this occasion we bid farewell to a very experienced CA researcher, Mr Gerrie Trytsman. Gerrie has been involved with CA research since 1997 and was instrumental in the implementation and management of the cover crop and livestock integration work package.



Participants at the annual CA research forum held on 27 September 2022 at Farmhouse58, Muldersdrift. Gerrie Trytsman is sitting second from left in the right-hand photo.

The ***terms of reference*** of this forum is as follows:

- Feedback and review of technical (progress) reports
- Evaluation of proposals (by selected 'experts' on CA evaluation panel)
- Identify funding priorities and target groups/areas
 - Identify new potential projects in different regions and topics
 - Coordinate new project proposals and project teams
 - Identify urgent (ad hoc) research and awareness needs
- Represent CA FIP in different regions – awareness and scouting for opportunities and needs

As part of their function to support the MT to channel a portion of their funds towards CA research, the CA forum guided by the CA Facilitator (Dr Smith), has created a CA evaluation panel, comprising a range of mostly local, but also international experts where necessary, to assist in the evaluation of new CA project proposals, as well as annual progress reports. A range of criteria has been developed with inputs from all stakeholders for this purpose. These CA panel members are being involved in the CA forum as far as possible.

**AGENDA OF THE MAIZE TRUST / ASSET RESEARCH
CONSERVATION AGRICULTURE (CA) RESEARCH FORUM MEETING
ON 27 SEPTEMBER 2022 AT 08H30 for 09H00
Farmhouse 58, Muldersdrift (<https://www.farmhouse58.co>) (or per zoom link)**

Discussion points	Responsible person
1. OPENING AND WELCOME	Chair
2. ATTENDANCE REGISTER & INTRODUCTION OF PARTICIPANTS	Chair
3. ADDITIONAL POINTS	Chair
3.1 Short introduction to Farmhouse58	
3.2 Background to CA Research Forum meeting and CA evaluation for The Trust – panel, process and criteria	Hendrik Smith (ASSET Research / MT)
3.3	
3.4	
4. STANDING POINTS ON AGENDA	
4.1 Presentations of existing CA projects: Focus on 2021-22 annual reports	
4.1.1 CA FIP project in Maluti & Mpumalanga Highveld (commercial farming) - Agronomy - Soil - Cover crops & livestock integration	Jaap Knot (ASSET Research) Gerrie Trytsman (ASSET Research) Gerhard du Preez (NWU)
4.1.2 CA FIP project in Ottosdal (commercial farming) - Agronomy - Soil - Cover crops & livestock integration	Andre Nel (ASSET Research) Gerrie Trytsman (ASSET Research) Gerhard du Preez (NWU)
4.1.3 CA FIP adaptive research projects in KZN (Smallholders) - Bergville, KZN - Southern, KZN - KZN Midlands	Erna Kruger and team (Mahlathini Development Foundation)
4.1.4 Financial modelling analyses of different systems in different CA FIP projects	Mary Maluleke (ASSET Research)
4.1.5 ARC - Grain Crops: Research on <i>Conyza</i> weed	Maryke Craven (ARC)
5. OTHER RELEVANT CA INITIATIVES	
5.1. The impact of conservation agriculture on maize ear rots and resultant mycotoxin production in commercial and smallholder farming systems	Belinda Janse van Rensburg (ARC)
5.2 ARC Small Grains long term on-station trial	Lientjie Visser (ARC)
5.2 ARC Small Grains long term on-station trial	
5.3 UFS trials	Gert Ceronio (UFS)
5.4 Restore Africa Funds, Cultivating Carbon, Regenerative Association of Southern Africa	James Blignaut (ASSET Research), Andrew Ardington (Regen Agricultural Association of SA)
5.5 Other	
6. NEW PROJECTS / PROJECT PROPOSALS / AMENDMENTS	
6.1	
6.2	
6.3	
7. ANNOUNCEMENTS / GENERAL	
7.1 Upcoming events such as conferences and farmers days	ALL
7.2 Other	
8. DATE OF NEXT MEETING To be announced.	Chair
9. CLOSURE	

Participation in national and international CA initiatives and events

Participation in national CA forums and events is seen as an important objective to continuously improve the enabling environment for CA to flourish. Several key issues and initiatives are being addressed by these forums. In this regard ASSET Research held a symposium on 14 March at the University of Stellenbosch, to showcase its various research programmes, including CA. For the CA programme, the following speakers were selected based on the fact that they are young scientist that have been doing their studies in projects under the CA FIP:

Name: Ané Loggenberg

Title: Soil ecosystem restoration under conservation agriculture

Name: Palesa Mathabo Motaung

Title: Soil health of smallholder farms under conservation agriculture in Bergville area, KwaZulu-Natal

Name: Mary Maluleke

Title: The Financial case of Conservation Agriculture in South Africa: Evidence from the field

Name: Riana Reinecke

Title: A system dynamics approach to incorporate environmental indicators into economic outcomes of dairy production systems in South Africa

Name: Temakholo Nonjabuliso Mathebula

Title: Solidarity Networks during Climate Crises: Collaboratively exploring opportunities for conservation agriculture with Rural Women

The National Conservation Agricultural Task Force (NCATF) meeting was held in Klerksdorp, involving mostly government officials from national and provincial Landcare units; Dr Hendrik Smith gave feedback on CA FIP projects and Mary Maluleke (junior economist at ASSET Research) gave a presentation on the results of an economic analysis of different farming systems measured in the CA FIP projects. A field visit to the Ottosdal study area was also organised.



Photos 13 and 14: Participants of the National Conservation Agriculture Task Force (NCATF) meeting held in Klerksdorp from 20-22 July 2022 having discussions with the Ottosdal CA project farmer co-workers at the trial site (left) and the local Country Club (right).

APPENDIX 8: SUMMARY OF CA FIP EXPENSES

Summary of budget/expenses – period October 2021 to September 2022

PROJECTS AND WORK PACKAGES	YTD ACTUAL*	YTD BUDGET	YTD VARIANCE
Support Regional CA Awareness activities	78 574	87 000	8 426
Support for a National CA Innovation Platform (Research Forum)	41 670	50 000	8 330
Ottosdal research project in North West Province			
Soil	123 281	123 426	145
Cover crops	138 194	138 830	636
Agronomic statistics	103 030	122 000	18 970
Programme management	135 153	138 384	3 231
Field trial activities	65 220	68 031	2 811
Ottosdal Total	564 877	590 671	25 794
Smallholder CA Research with MDF	866 079	866 079	0
Maluti systems research on CA			
Programme management	69 975	70 490	515
Soil	143 670	144 162	492
Cover crops	139 823	143 350	3 527
Monitoring and facilitation	172 334	172 882	548
Maluti Total	525 802	530 884	5 082
Mpumalanga Highveld systems research on CA			
Programme management	64 205	64 322	117
Soil	196 650	197 232	582
Cover crops	136 052	136 166	114
Monitoring and facilitation	246 760	246 926	166
Mpumalanga Highveld Total	643 667	644 646	979
Total Maize Trust project expenses	2 720 728	2 769 280	48 552

* Table reflect actual expenditures from October 2021 to August 2022 plus anticipated expenditures for September 2022.