APPENDIX 5: KWAZULU-NATAL MIDLANDS ANNUAL REPORT

CA Farmer Innovation Programme (CA-FIP) for smallholders in KZN Midlands.

Period: October 2019 - September 2020

Farmer Centred Innovation in Conservation Agriculture in Midlands of KwaZulu-Natal

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Project implemented by:

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Contents

Executive summary

The KZN Midlands programme is in its third year of operation, expanding on the model and process piloted in the Bergville area. Communities targeted were increased to include Impendle and Tbamhlophe. The total number of participants in learning and awareness raising events were 142 (Ozwathini and Ntabamhlope) and the total number of farmer level trials implemented increased from 85 in 2018-2019 to 204 in 2019-2020, of whom 164 managed to both plant and harvest from their CA trials.

Recorded yields form CA trials were low, despite all farmers commenting on improved production and reasonable rainfall (despite a late start). Average Maize yields for the CA trial plots was 1,35 t/ha and those for the conventional control plots was 0,99 t/ha. Bean yields average 0,78 t/ha.

An open day was held in Ozwathini, focused on cover crops, with inclusion of local and regional stakeholders, towards the end of September 2019. The strip cropping demonstration trial with perennial fodder species was held in Ozwathini, in association with KZNDARD in January 2020. This was followed by a fodder supplementation workshop process, hosted by Brigid Letty from the INR in May 2020. The annual farmers' days could not be hosted due to the COVID-19 pandemic. MDF participated in a national webinar hosted by the Integra Trust to disseminate the results of our work more widely, as well as a Gender integration webinar for women in the informal sector, hosted by PLAAS (UWC) in August 2020.

Rainfall and run-off records were kept for a selected number of participants and water productivity calculations were done for 3 participants from Mayizekanye (Swayimane). The results indicated significantly improved grain crop water productivity for CA maize and legume intercropped plots, when compared to maize only plots. The water productivity for biomass production was significantly higher for the maize and cowpea intercropped plots, and the maize and bean intercropped plots when compared to maize only CA plots.

Soil health analysis indicated significantly improved soil health parameters for 3rd year participants in both Swayimane and Ozwathini.

Background and Organisational Information

Mahlathini Development Foundation (2003-2020) is one of the only NGOs in South Africa focussing on promoting collaborative pro-poor agricultural innovation. As such MDF is a specialist NGO working in the fields of participatory research, training and implementation, focussing on agroecological approaches.

Introduction of CA into any farming system requires the creation of a process and environment of continuous innovation, learning and change in a number of different areas, including social, economic, environmental and agronomic considerations. In the smallholder context it requires the design, introduction and facilitation of a reasonably complex IS (innovation system) approach by the implementers, and of practice, labour and resources (including natural and financial resources) by the farmer that has system wide implications. There is an interplay of a number of different factors, all of which need to be integrated, thus requiring a well-designed and facilitated IS approach.

The IS model applies a family of approaches and methodologies, such as the Farmer Field School (FFS) approach and participatory monitoring & evaluation (PM&E), to facilitate awareness, learning, implementation and research all together. The key voluntary participants of this process are farmers from a locality or village who should be organised into learning groups (farmers generally are already organised into structures such as savings and credit groups, associations or cooperatives). A number of farmers in that group volunteer to undertake on-farm experimentation, which creates an environment where the whole group learns throughout the season by observations and reflections of the trials' implementation and results. They compare various CA treatments with their standard practices, which are planted as control plots. This provides an opportunity to explore all aspects of the cropping system, its socio-economic context and feasibility, as well as the grain and legume value chain in the area. The whole value chain is considered: input supply, production aspects, harvesting and storage, processing and marketing

Horizontal expansion (scaling out) from village nodes to surrounding farmers and villages in the area, working with organised farmer groups (or IPs) in collaboration with stakeholders in the

SELECTION AND COMMUNITY LEVEL PROCESS

PRE-CONDITION; Farmers active in maize production with some level of social organisation

1. Entry into community; through word of mouth from community members (individual and group requests), government officials, other service organisations,
2. Set up introductory meetings at community level, including authorities, to introduce CA and the process:
    - Set up learning or interest group (20-30 people)
    - Members of learning group volunteer for farmer led experimentation (usually 9-12 members in the first year), while the rest of the group learns alongside them
    - These members agree to do a CA trial alongside their control (normal way of planting)
    - Trials are usually 100,400 or 1000m^2 (*small areas to reduce risk)*
    - The programme provides inputs for the trial, the inputs for control and all labour are provided by the farmer (*the risk of implementing the new idea initially sits with the programme not the farmers. From the 2nd year onwards, the farmers pay a standard 30% subsidy towards the costs of inputs for their trials)*
    - Farmers are trained in the implementation of CA; pre-planting spraying (use of knapsack sprayers) and field preparation, use of herbicides, layout of plots and planting in basins and rows using a range of no-till tools (hand planters, animal drawn planters and or two row tractor-drawn planters). The choice of implements depends on the scale of farming and farmers' choice. Aspects such as top dressing, weeding and pest control are covered during the season as well.
    - The first-year trial layout is pre-determined through the programme – to include close spacing, inter cropping and different varieties of maize (choice of traditional OPV or hybrid seed- according to farmer preferences) and legumes (sugar beans, cowpeas)
    - From the 2nd year onwards, farmers start to add their own elements to the experimentation depending on their learning, questions and preferences. Cover crops (both summer and winter) and crop rotation options are introduced.
    - Researcher managed "trials" are also set up at individual homesteads, to work alongside the more enthusiastic and committed participants and to explore issues such as soil health, carbon sequestration soil fertility, water productivity, moisture retention, run-off and specific aspects of the CA system – such as seeding and seeding rates of cover crops etc.
    - As a minimum, 2-4 learning sessions per season in the learning group are held each year, building in complexity and content. 1 review session for the season and one planning session to plan experimentation for the upcoming season
    - Planters and knapsack sprayers are provided to the learning group to share, manage and maintain
    - Setting up of VLSA's (village savings and loan associations), farmer centres and joint harvesting, storage and milling options are promoted
3. Each season farmers days are organised in each area, jointly with the learning groups, CA forums and innovation platforms are promoted where all stakeholders in a region join these forums to share, discuss and plan together. This includes role players such as DARD, Social Development, Land Care, Local and District Municipalities, Agribusiness service providers, NGOs

region has shown great promise for expansion of interest in and longer term sustainability of the implementation of CA practices among smallholders. It means that a number of villages in close proximity become involved and this provides an opportunity for organising farmers around issues in the value chain such as bulk buying, transport, storage and marketing. It creates an option to set up farmer service centres at central nodes that can provide easy access to inputs and services. The model also provides for learning over a period of time, which has proven essential to allow each participant farmer to experiment with and master/adapt the CA principles for at least 4 years. The more experienced farmers become mentors to the new entrants and some undertake the role of local facilitation and support to their villages and groups. It also provides a platform where other farmers and interested parties in the area can engage and become involved

The adaptive trials are also used as a focus point for the broader community to engage through local learning events and farmers' days. Stakeholders and the broader economic, agricultural and environmental communities are drawn into these processes and events. Through these events *Innovation Platforms (IPs)* are developed for cooperation, synergy between programmes and development of appropriate and farmer led processes for economic inclusion. These IPs also provide a good opportunity to focus scientific and academic research on the 'needs' of the process.

In this season (2019-2020) we have focused on the following elements of the model, namely:

a) Support farmers in their 1st to 3rd seasons of implementation
b) Intercropping and crop rotation
c) Planting of short season maize varieties
d) Summer cover crops; sunflower, Sun hemp, Babala, Dolichos beans
e) Continuation with experimentation with winter cover crops, including new species requested by farmers (Lucerne, clover, turnips)
f) Introduction of strip cropping with perennial fodder species as an implementation option
g) Expansion of use of two-row CA planters for larger fields and
h) Continued support for VLSAs (Village savings and Loan associations) and small business development training for these participants and

Key activities: October 2019 to September 2020

204 Participants across 5 areas and 14 villages undertook the CA experimentation process this season. Due to late onset of summer rains only 164 of these participants both panted and obtained yields. In some cases, the fields were planted and then subsequently neglected due to continuing unpredictability of the weather and thus due to overgrowth of weeds and livestock invasions a number of participants did not harvest their crops.

This season, along with the preferred maize varieties, SC701 and PAN6479, three short season varieties were used in villages where late planting has been necessary due to late onset of rain and variable rainfall. These varieties are PAN3A-173 (ultra-early white), PAN 5A-291 (medium early- white) and PAN 5A-190 (medium early- yellow).

Two-row planters (tractor-drawn) are now available in both Swayimane (shared by 4 learning groups) and Ozwathini (shared by one large learning group). Sessions have been held to ensure the correct operation and maintenance of these planters and the extension staff from KZNDARD have been brought in to assist in this regard.

A seasonal thematic focus on cover crops was kick-started in Ozwathini with an open day that involved members of all the Midlands learning groups, KZNDARD, LandCare and AGT Foods. This aspect is crucial for soil fertility and soil health improvement, soil erosion control on the steeper slopes and livestock integration. Interest in the use of cover crops has increased dramatically within the learning groups in the Midlands, due to early positive results obtained by the handful of participants who have tried this to date. The strip cropping farmer level experimentation process with perennial fodder species (such as Lespediza, Bahia grass (Paspalum)and Catstail grass (Digiteria)), is part of this focus. In addition, three further workshops were held in the area, focussing on crop-livestock integration aspects; including supplementation, hay making disease management and calf rearing and around 12 participants undertook experimentation in livestock supplementation.

Participants numbers in existing learning groups in Swayimane and Ozwathini have increased dramatically in this season. The partnership with Lima RDF in Ntabamhlophe (Estcourt) has been continued and strengthened through direct involvement of LandCare in this area and a new partnership has been initiated with the INR (Institute of Natural Resources) in Impendle as part of an initiative to pilot soil and water conservation practices in the catchment

The Cornfields (Estcourt area) focus has continued, despite the understanding both in the community and by the facilitators that this is likely a very marginal area for maize production- due to climatic conditions and extremely poor soils. The learning group members have continued to do the best they can manage, under the circumstances.

Budget

The budget for this project of R551 225 was completed as of the end of July 2020. The remaining activities of annual reviews with participants and their planning for the 2020/21 cropping season is to be implemented through a different budget. The project is considered complete at the date of submission of this report.

Results achieved to date

Fourteen learning groups have been supported under this process. Training/learning workshops have been conducted for the following topics:

- **How to implement CA:** introduction to the principles, soil health, crop diversification and different planting options for CA
- **Working with herbicides and knapsack sprayers**: information on different herbicides, their uses and safety measures, as well as operation of knapsack sprayers, protective clothing, etc.
- **Trial plot layout and planting** using different CA planting equipment such as hoes, MBLI planters, and animal drawn not till planters.
- **Inclusion of cover crops:** both summer and winter cover crop options in different planting regimes; separata blocks, alley cropping, relay cropping and strip cropping and

- **Livestock integration:** fodder supplementation, hay making, disease management and calf rearing

The learning groups provide the innovation platforms also for discussion of the value chain issues, such as bulk buying, harvesting, storage and milling options and marketing.

The table below outlines activities related to objectives and key indicators for the period of October 2019-September 2020.

Table 1: SUMMARY OF PROGRESS (OCTOBER 2019- SEPTEMBER 2020) RELATED TO OBJECTIVES AND KEY ACTIVITIES

Objectives	Key activities	Summary of progress	% completion and comment
OBJECTIVE 1: To engage in participatory research related to the smallholder conservation agriculture farming system; including aspects of soil health, water conservation and increased productivity and diversity using a learning systems approach.	Key activity 1. Farmer level experimentation and demonstrations in fodder production systems	Planting and assessment of different fodder crops (annual and perennial) into the CA experimentation process: -Intercropping with legumes and cover crops in 8 villages -Strip cropping with perennial fodder options in 2 villages	Cover crops planted by 20 participants , harvested for livestock feed and seed kept by a small proportion (100% completion)
	Key activity 2. Soil health and water conservation monitoring	Researcher managed quantitative outcomes for a number of soil health and water conservation indicators -Soil fertility samples; repeat (16) samples across 2 villages -Soil health samples; 4 participants/ 4 villages -Run-off plots and rain gauges: 1 village -Water productivity: 4 participants across 4 villages	Soil fertility samples results have been analysed reported on in the interim report Soil health sample results have been analysed and report on. (100% completion)
	Key activity 3. Stakeholder engagement in participatory research:	Articles and promotional material to engage stakeholders in the broader environment and sharing of information through various innovation platforms and processes; including the internet, social and networking platforms and conferences -farmers open day in Ozwathini (September 30th, 2019) -Development of a Cover crops handout and poster for use in stakeholder events -Writing of a book chapter for CABI:CA in Africa -3 multi stakeholder learning workshop in Ozwathini on aspects of livestock integration -Presentations in two webinars; Integra trust and PLAAS to create awareness of the CA SFIP	(100% completion)
OBJECTIVE 2: To increase the sustainability and efficiency of CA systems	Key activity 1: Farmer-centred Innovation Systems Research:	Jointly design and implement farmer-led adaptation trials and a basket of farmer level experimentation protocols from CA best practice options.	Spraying, planting, top dressing, pest control. Growth monitoring has been conducted and

in the study areas giving specific attention to the value chain and incorporation into the broader agribusiness environment.	Key activity 2. Value chain and agribusiness support: Key activity 3: Support Local facilitators:	-204 farmer level trials set up across 10 villages; including intercropping with legumes and cover crops options. Promotion and of VSLAs farmer centres and small business development among individual smallholder farmers - Start -up of 1 new VSLAs (Ozwathini) Training and mentoring support for at least 6 Local Facilitators to increase their capacity organise local farmers, logistics and planning for cropping options and monitoring of the farmer level experimentation. -6 Local facilitators have been capacitated to support their groups – spraying, input supply and delivery, plot layout, and crop growth monitoring	yields have been measured (100% completion) ND In a number of the villages, individuals who can fulfil the role of an LF have not come forward and this is still managed by MDF staff (100% completion)
OBJECTIVE 3: Strengthen and use different innovation platforms as avenues to scale out sustained collective action and CA practices.	Key activity 1. Further develop the Participatory Monitoring and Evaluation (PM&E) framework: Key activity 2. Facilitate innovation platforms for learning and networking: Key activity 3. Strengthen Innovation Platforms:	Experienced farmers (farmer facilitators) and the facilitation team assist in scientific, ongoing monitoring (qualitative and quantitative) and support to farmer experimenters. -Quantitative research elements conducted in partnership with 4 experienced farmers across 4 villages (incl run-off plots, rain gauges, water productivity and soil health analysis Learning group sessions for discussion and learning. -At least 3 sessions have been held with learning groups across 5-6 villages – themes have included CA principles, spraying, inclusion of fodder and cover crops, expansion into larger areas, marketing options, cooperative development and entrepreneurship Innovation platform events: -Ozwathini farmers day; Focus on Cover crops, Inclusion of LandCare, KZNDARD, AGT Foods and participants from Swayimane -Ntabamhlophe CA awareness day co-hosted by LandCare Bi-annual steering committee meetings (Not done as yet)	Two new interns with MSc's in Agriculture and Soil Science have been brought on board to assist. Crop growth monitoring using the pendragon e-survey has been continued this season (100% completion) (100% completion) ND

A performance dashboard is indicated below. This provides a snapshot of performance according to suggested numbers and outputs in the proposal.

Table 2: PERFORMANCE DASHBOARD; SEPTEMBER 2020

Outputs	Proposed (March 2019)	Actual (Feb 2020)
Number of areas of operation	2	5
Number of villages active	12	14
No of local facilitators	6	6
No of direct beneficiaries; farmer level experimentation	120	204 (164)
Fodder trials with KZNDARD	2	2
Stakeholder Events	3	3
Value chain support	Not defined	Local marketing and joint procurement of calves and inputs for 3 learning groups
Articles, conferences, webinars	1-3 of ea	1 book chapter, 2 webinars
Soil fertility samples	90	32
Soil health samples	84	67

The table below summarises farmer level CA trial implementation for the 2019-2020 planting season. A total of 204 trial participants have planted trials this season, showing a significant upswing in interest.

Table 3: SUMMARY OF FARMER INNOVATION NUMBER AND AREAS PLANTED PER VILLAGE IN THIS CA PROCESS; KZN MIDLANDS, 2019-2020

Area	Village	2016	2017	2018	2019	Experi-mentation	Comments; incl planters used.
Estcourt	Cornfields	8	9	10	13	Intercropping; PAN 6470, Pan 148 beans, cowpeas	Demonstration plot at Mr Miya's homestead.
New Hanover; Swayimane	Mayizekanye 1 Thembi Mkhize		6	8	15	Intercropping: SC701, PAN 9292 beans, cowpeas	Hand hoes and MBLI planters used.
	Mayizekanye 2 Mrs Nxusa		9	8	12	Intercropping: SC701, PAN 9292 beans, cowpeas	Hand hoes and MBLI and two row planters used
	Mayizekanye 3 Nomusa Shandu		8	9	19	Intercropping: SC701, Pan9292 beans, cowpeas	Hand hoes and MBLI and two row planters used
	Gobizembe		9	12	19	Intercropping: SC701, PAN 148 beans, cowpeas	Hand hoes and MBLI planters used.
Ozwathini	Swedi Bamshela Hlatikhulu Emathulini			15	44	Intercropping: SC701, PAN 9292 beans, cowpeas	Hand hoes and MBLI and two row planters used
Tabamhlophe	De Klerk, Emdwabu Loskop			20	45	Intercropping: PAN6479 PAN148 beans, cowpeas	Hand hoes and MBLI planters used.

Impendle	Emapanekeni Ntwasahlobo				40	Intercropping: PAN6479 PAN148 beans, mixed brown cowpeas	Hand hoes and MBLI planters used.
TOTAL	**14**	**26**	**41**	**82**	**204 (164)***	**4,2 ha trial plots 1,5 ha control plots**	

NOTE*: 204 Participants undertook the experimentation at the beginning of the season and 164 (80%) participants actually planted and obtained yields from their CA trials. Most to the attrition in the group was due to late onset of summer rains.

Overall process

As this is an existing 'technology' the farmer level experimentation is in essence an adaptation trial process.

Year 1:

Experimental design is pre-defined by the research team (based on previous implementation in the area in an action research process with smallholders). It includes a number of different aspects:

- Intercropping of maize, beans and cowpeas
- Introduction of OPV and hybrid varieties for comparison (1 variety of maize and beans respectively)
- Close spacing (based on Argentinean system)
- Mixture of basin and row planting models
- Use of no-till planters (hand held, animal drawn and tractor drawn)
- Use of micro-dosing of fertilizers based on a generic recommendation from local soil samples
- Herbicides sprayed before or at planting only
- Decis Forte used at planting and top- dressing stage for cutworm and stalk borer
- Planting of cover crops; summer and winter mixes

Experimental design includes 2 treatments; planter type (2) and intercrop (2). See the diagram below.

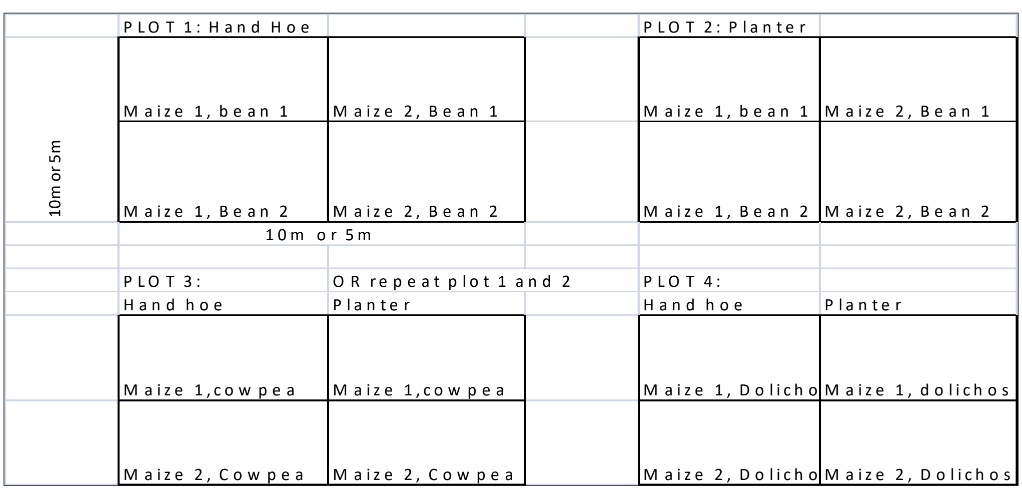


Figure 1: Example of plot layouts for the 1st level farmer trials

The basic process for planting thus includes: Close spacing of tramlines (2 rows) of maize (50cmx50cm) and legumes (20cmx10cm) intercropped, use of a variety of OPV and hybrid seed, weed control through a combination of pre- planting spraying with herbicide and manual weeding during the planting season and pest control using Decis Forte, sprayed once at planting and once at top dressing stage.

For the tractor drawn two row planter the layout has been adapted to incorporate both close spacing and inter cropping. Rows are planted with the following order and spacing; Maize-50cm -Beans-25cm-Beans-50cm Maize

Year 2:

Based on evaluation of experimentation progress for year 1, farmers have additional options that they can choose from. Farmers also take on spraying and plot layout themselves:

- A number of different OPV and hybrid varieties for maize, inclusion of short season maize varieties
- A number of different options for legumes (including summer cover crops)
- Planting method of choice
- Comparison of single crop and intercropping planting methods
- Use of specific soil sample results for fertilizer recommendations
- Early planting
- Own choices

Year 3:

Trials are based on evaluation of experimentation process to date; to include issues of cost benefit analysis, bulk buying for input supply, joint actions around storage, processing and marketing. Farmers design their experiments for themselves to include some of the following potential focus areas:

- Early or late planting; with options to deal with more weeds and increased stalk borer pressure.
- Herbicide mix to be used pre and at planting (Round up, Dual Gold, Gramoxone)
- A pest control programme to include dealing with CMR beetles
- Intercropping vs crop rotation options
- Spacing in single block plantings
- Use of composted manure for mulching and soil improvement in combination with fertilizer
- Soil sample results and specific fertilizer recommendations
- Planting of Dolichos and other climbing beans
- Summer and winter cover crops; crop mixes, planting dates, management systems, planting methods (furrows vs scatter)
- Seed varieties; conscious decisions around OPVs, hybrids and GM seeds; inclusion of short season maize varieties

Rainfall and runoff

Runoff (stormflow or surface runoff of water) is generated by rainstorms and its occurrence and quantity are dependent on the characteristics of the rainfall event, i.e. intensity, duration and distribution (Schulze, 2011). There are, in addition, other important factors which influence the runoff generating process. These factors include the infiltration capacity of the soil, the soil moisture content when the rainfall event occurred, the soil type, presence of capping/crusting and slope.

In addition, the presence of above ground vegetation intercepts some of the rainfall and reduces raindrop impact and thus crusting of the soil. Vegetation also has a significant effect on the infiltration capacity of the soil. The root system as well as organic matter in the soil increase the soil porosity thus allowing more water to infiltrate. Vegetation also retards the surface flow particularly on gentle slopes, giving the water more time to infiltrate and to evaporate. Thus, vegetation reduces runoff substantially, compared to bare ground (Critchley & Siegert, 1991).

For the purposes of comparing the effect of Conservation Agriculture on runoff in the context of an agricultural cropping field, only surface runoff has been considered.

Runoff plots are used to measure surface runoff as well as erosion through removal of sediment. under controlled conditions. In this instance runoff microplots, as designed previously by UKZN researchers (Mutema, Jewitt, Chivenge, & Kusangaya, 2017) have been used.

Runoff microplots consist of galvanised metal sheeting frames 1mx1m, inserted 10 cm into the ground and leaving another 10 cm above ground to eliminate run-on water during rain events. A spirt level was used to keep the runoff plots levelled and the slope has been considered (runoff plots were not installed on slopes higher that 7 %) when installing the runoff plots. Surface water and sediment generated are collected into a protected gutter through openings in a downslope side metal sheet. The gutter is fitted with a delivery pipe connected to a reservoir (in our case, a 25 L bucket, with a lid) about 1.5 m downslope. After each rainfall event, the total runoff volume (ml) from each micro-plot replicate was measured with a measuring cylinder (Dlamini, Jewitt, Lorenz, & Orchard, 2011). Sediment was noted on occasion, but not recorded.

The aims of the experiments are:

1. To ascertain differences in runoff when comparing minimal tillage to conventional tillage.

METHOD:

Run-off pans were installed for Rita Ngobese in Gobizembe (Swayimane) for the 2018/19 and 2019/20 cropping seasons. One pan was installed in a CA plot (M+B intercrop) and one in a conventionally tilled plot, planted to a single crop of maize. Mrs Ngobese also has a rain gauge set up in her homestead. Participants take records for both rainfall and runoff for the cropping

A runoff microplot installed in a CA trial plot with maize and beans

Installing a runoff microplot installed in a conventionally tilled plot with maize

In season maintenance of collection buckets season; usually October- April. The period however depends on the start and end of the rainy season.

The small table below provides a summary of the rainfall and runoff data recorded by Mrs Ngobese.

Date	Ave monthly rainfall (SASRI*) (mm)	Rainfall (mm)	Runoff CA plot (L)	Runoff Control plot (L)	% Conversion of rainfall to run-off	
					CA	Control
Feb-20	148	126	11	30		
Mar-20	124	46,5	4,7	5		
Apr-20	103	221	10,5	15		
Total 2020	954 (June'19-June '20)	393,5	26,2	50	6,7 %	12,7 %
Total 2019					0,6 %	1,2 %

Note:* Weather station data from New Hanover, the closest small town, was provided by SASRI

Mrs Ngobese has been implementing CA in her plot for a period of three years. The results in the table provide a clear indication that CA and intercropping reduces run-off by 50% when compared to conventional tillage with monocrop options. The difference in runoff between the CA and conventionally tilled plots is much higher for the months with higher rainfall, which also includes high intensity rainfall events, and further indicates the advantages of CA for a reduction in runoff and by inference improvement in infiltration of these plots.

Soil health

The intention is to compare the soil health characteristics for a number of cropping options within the CA trials over time and also to compare conventionally tilled mono-cropped control plots with CA trial plots over time.

The Haney soil health tests (as analysed by Soil Health Solutions in the Western Cape and Ward Laboratories in the USA) provides insight into microbial respiration and populations in the soil, organic and inorganic fractions of the main nutrients N, P and K, and assessment of organic carbon and percentage organic matter (%OM). An overall soil health score (SH) is also provided for each sample.

Method

Sampling:

Sampling is done at the same time every year; during September, after harvest and prior to start of seasonal rain, according to international conventions (Stolbovoy, et al., 2007).

- CA plots: 10x10m plots are marked and 10cm depth cores are taken (with a soil auger), taking 20 samples along a zig-zag pattern across the plot. These are combined, thoroughly mixed and then 500g is placed in a plastic bag and sealed. These bags are kept in a cool, dark place until delivery to the soil health analysis laboratory – usually within 4-6 weeks of taking the sample

- Control plots; 20 samples are taken in a zig-zag pattern across the dimension of the control plot; these vary from one participant to the next and are otherwise treated in the same manner as the CA plot samples above.
- Veld samples: This changed after the first two seasons, to reduce potential variability in the samples. A patch of undisturbed veld, as close as possible to the participant's cropping field is chosen, to also have the same basic visual characteristics as the field in question. 4 sub-samples are taken at 10-15cm depth at the 4 compass positions adjacent to the cropping field. NOTE: It has been the team's experience that the values of the veld samples vary substantially even in the same village or the same vicinity as a field. The practise of using one veld sample for two to three different farmers in the same village was thus discontinued and a decision made to use a section of veld as close as possible to the cropping field. In addition, Veld in smallholder farming areas under communal tenure, cannot be regarded as "pristine", given heavy grazing patterns and frequent burning. It is however assumed that the soil is undisturbed in terms of tillage and gives an indication of the general conditions of the soil in the vicinity of the cropping fields.

Samples were air dried and stored for a period of 2-4 weeks at room temperature (20-24°C), prior to analysis.

Samples have been collected for the 2018/19 and 2019/20 seasons in two villages:

- Mayizekanye (3 participants_: 3rd year of implementation
- Gobizembe (1 participant); 3rd year of CA implementation

Laboratory analysis

Laboratory analysis was undertaken by Soil Health Solutions, linked to WARD Laboratories in the USA. Each soil sample received in the lab is dried at 50°C for 24 hr and ground to pass a 4,75 mm sieve. The dried and ground samples are scooped, with the weight recorded using a Sartorius Practum 2102-1S, into two 50 ml centrifuge tubes (4 g each) and one 50 ml plastic beaker (40 g) that is perforated and has a Whatman GF/D glass microfiber filter to allow water infiltration. The two 4 g samples are extracted with 40 ml of DI water and 40 ml of H3A respectively, for a 10:1 dilution factor. The samples are shaken for 10 minutes, centrifuged for 5 minutes, and filtered through Whatman 2V filter paper. The water and H3A extracts are analysed on a Seal Analytical rapid flow analyser for NO_3-N, NH4-N, and PO_4-P. The water extract is also analysed on an Elementar TOC select C: N analyser for water-extractable organic C and total N. The H3A extract is also analysed on an Agilent MP-4200 microwave plasma for Al, Fe, P, Ca, and K.
The 40 g soil sample is analysed for CO2-C ppm after a 24- our incubation at 25o C. Initially, the sample is wetted through capillary action by adding 18 ml of DI water to an 8 oz. glass jar (ball jar with a convex bottom) and placed in the jar and then capped. Solvita paddles can be placed in the jar at this time and analysed after 24 hrs with a Solvita digital reader. Alternatively, we use a system that we call HT-1, where at the end of 24-hour incubation, the CO2 in the jar can be pulled through a LiCor 840A IRGA, which is a non-dispersive infrared (NDIR) gas analyser based upon a single path, dual wavelength infrared detection system.

SOM% is a gravimetric expression of the organic material fraction lost from combustion at 360°C for 3 hours. Also termed the loss in ignition calculation method, (LOI%).

Soil health tests parameters[1]

The Haney method uses nature's biology and chemistry by: (1) using a soil microbial activity indicator; (2) a soil water extract (nature's solvent); and (3) the H3A extractant, which mimics the production of organic acids by living plant roots to temporarily change the soil pH thereby increasing nutrient availability.

These analyses are benchmarked against natural veld for each participant, due to high local variation in soil health properties, measured at different times. The veld scores provide for high benchmarks to compare the cropping practices against.

Soil Respiration 1-day CO2-C: This result is one of the most important numbers in this soil test procedure. This number in ppm is the amount of CO_2-C released in 24 hours from soil microbes after soil has been dried and rewetted (as occurs naturally in the field). This is a measure of the microbial biomass in the soil and is related to soil fertility and the potential for microbial activity. In most cases, the higher the number, the more fertile the soil.

Microbes exist in soil in great abundance. They are highly adaptable to their environment and their composition, adaptability, and structure are a result of the environment they inhabit. They have adapted to the temperature, moisture levels, soil structure, crop and management inputs, as well as soil nutrient content. Since soil microbes are highly adaptive and are driven by their need to reproduce and by their need for acquiring C, N, and P in a ratio of 100: 10: 1 (C:N:P), it is safe to assume that soil microbes are a dependable indicator of soil health. Carbon is the driver of the soil nutrient-microbial recycling system.

Water extractable organic C (WEOC): Consists of sugars from root exudates, plus organic matter degradation. This number (in ppm) is the amount of organic C extracted from the soil with water. This C pool is roughly 80 times smaller than the total soil organic C pool (% Organic Matter) and reflects the energy source feeding soil microbes. A soil with 3% soil organic matter when measured with the same method (combustion) at a 0-10cm sampling depth produces a 20,000 ppm C concentration. When the water extract from the same soil is analysed, the number typically ranges from 100-300 ppm C. The water extractable organic C reflects the quality of the C in the soil and is highly related to the microbial activity. On the other hand, % SOM is about the quantity of organic C. In other words, soil organic matter is the house that microbes live in, but what is being measured is the food they eat (WEOC and WEON).

If this value is low, it will reflect in the C02 evolution, which will also be low. So less organic carbon means less respiration from microorganisms, but again this relationship is unlikely to be linear. The Microbially Active Carbon (MAC = WEOC / ppm CO_2) content is an expression of this relationship. If the percentage MAC is low, it means that nutrient cycling will also be low. One needs a %MAC of at least 20% for efficient nutrient cycling.

Water extractable organic N (WEON): Consists of Atmospheric N_2 sequestration from free living N fixers, plus organic matter degradation. This number is the amount of the total water extractable N minus the inorganic N (NH_4-N + NO_3-N). This N pool is highly related to the water extractable organic C pool and will be easily broken down by soil microbes and released to the soil in inorganic N forms that are readily plant available.

[1] Haney/Soil Health Test Information Rev. 1.0 (2019). Lance Gunderson, Ward Laboratories Inc.

Organic C: Organic N: This number is the ratio of organic C from the water extract to the amount of organic N in the water extract. This C:N ratio is a critical component of the nutrient cycle. Soil organic C and soil organic N are highly related to each other as well as the water extractable organic C and organic N pools. Therefore, we use the organic C:N ratio of the water extract since this is the ratio the soil microbes have readily available to them and is a more sensitive indicator than the soil C:N ratio. A soil C:N ratio above 20:1 generally indicates that no net N and P mineralization will occur. As the ratio decreases, more N and P are released to the soil solution which can be taken up by growing plants. This same mechanism is applied to the water extract. The lower this ratio is, the more organisms are active and the more available the food is to the plants. Good C:N ratios for plant growth are <15:1. The most ideal values for this ratio are between 8:1 and 15:1.

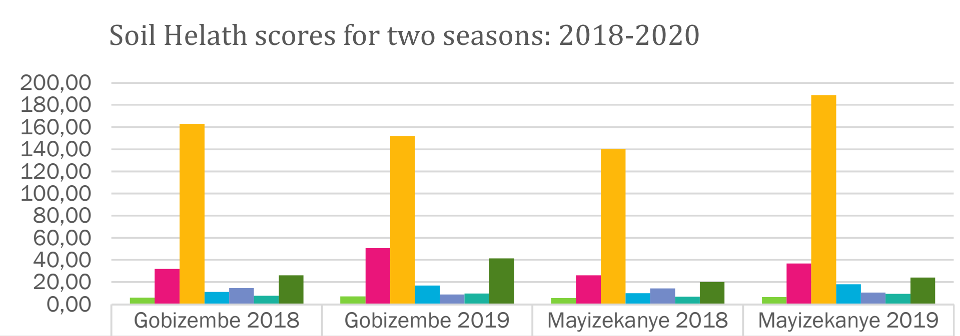
Soil Health Calculation: This number is calculated as 1-day CO_2-C/10 plus WEOC/50 plus WEON/10 to include a weighted contribution of water extractable organic C and organic N. It represents the overall health of the soil system. It combines 5 independent measurements of the soil's biological properties. The calculation looks at the balance of soil C and N and their relationship to microbial activity. This soil health calculation number can vary from 0 to more than 50. This number should be above 7 and increase over time.

Soil health scores

Three assumptions are made regarding SH scores:

- That SH scores for the CA trial plots will be higher than for the conventionally tilled control plots
- That SH scores will increase over time for CA trial plots and
- That SH scores for different cropping combinations, such as mono cropped plots, inter cropped plots and multi cropped plot will be different

1. *SH scores over time*



	Gobizembe 2018	Gobizembe 2019	Mayizekanye 2018	Mayizekanye 2019
%OM	5,85	7,05	5,51	6,30
CO2 - C(ppm)	32,05	50,70	25,93	36,86
Organic C (ppm)	163,00	152,00	140,14	188,71
Organic N (ppm)	11,10	17,00	9,96	17,96
C:N ratio	14,65	8,85	14,30	10,55
Soil health calculation	7,60	9,80	6,56	9,27
Soil aggregates	26,00	41,50	19,86	24,00

Figure 2: Comparison of soil health scores for two villages in the Midlands across two seasons

From the above figure the following can be seen:

- The soil health scores for both Gobizembe and Mayizekanye have increased substantially from 2018/19 to 2019/20, linked to increases in Co_2-C respiration, Organic C and organic N, despite a slight reduction in Organic C in Gobizembe.
- Both areas have shown a significant increase in the availability of Organic N comparative to the increase in organic C, which is likely the effect of continued intercropping with legumes (beans and cowpeas) in their CA trial plots. This increase has also led to a reduction in the C:N ratio and a subsequent availability of nutrients to the crops.
- The percentage soil aggregate stability has also increased for both areas.

The general assumption here is that if the level of organic C in a plot is high, then the microbial respiration will also be high, as will the soil health score and vice versa. This is not always the case, as the relationship is not necessarily a linear one.

The CO_2-C respiration also gives an indication of the potential mineralisation of N for the soil as well as organic matter content. The small table below indicates these relationships.

Test results ppm CO_2-C	N mineralisation potential	Biomass
>100	High-N potential soil. Likely sufficient N for most crops	Soil very well supplied with organic matter. Biomass>2500ppm
61-100	Moderately-high. This soil has limited need for N supplementation	Ideal state of biological activity and adequate organic matter
31-60	Moderate. Supplemental N required	Requires new applications of stable organic matter. Biomass <1200ppm
6-30	Moderate-low. Will not provide sufficient N for most crops	Low in organic structure and microbial activity Biomass <500ppm
0-5	Little biological activity; requires significant fertilisation	Very inactive soil. Biomass<100ppm. Consider long term care

2. *Different CA cropping options*

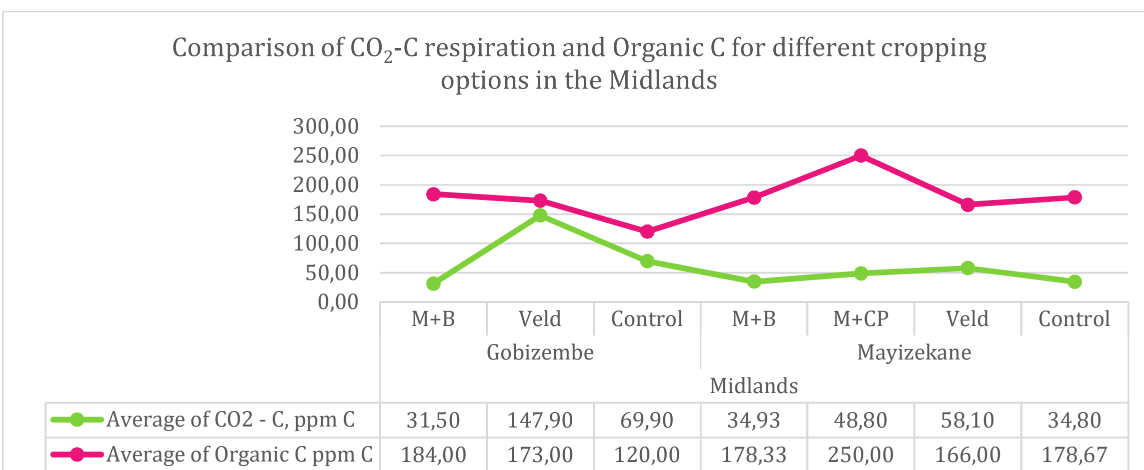
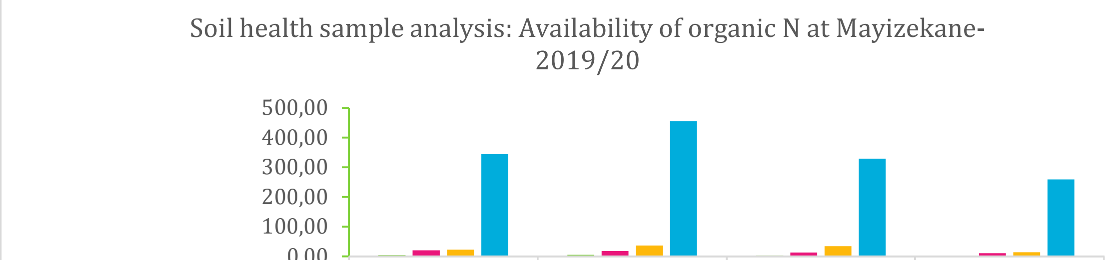


Figure 3: Carbon respiration and organic C for different cropping options in the Midlands.

For the above figure the following trends can be seen:

- ➢ The CA intercrops (M+B and M+CP) provide for higher levels of Organic C accumulation than the CA control, where a maize mono-crop is planted year after year.
- ➢ The CO_2-C respiration values for all the plots are however between 31-60, indicating moderate mineralization potential and the need for addition of stable organic matter to the system.

Despite this, the improvement in availability of organic N in Mayizekanye has been notable this season.



	M+B	M+CP	control	Veld
N Long term release (ppm)	4,66	5,09	3,73	1,57
N Short term relsease (ppm)	19,51	18,11	13,12	10,34
N Immediate release (ppm)	22,36	35,60	34,35	14,10
R value of N	R344,60	R454,00	R329,19	R259,27

Figure 4: Analysis of availability of Organic N in Mayizekanye for the 2019/20 cropping season

When the results of the three participants form Mayizekanye are combined there is a clear indication of the advantage of the maize and cowpea intercrop, when compared to maize and beans and maize planted as a single crop under CA. The M+CP cropping option provides the highest levels of Long term, sort term and immediate release nitrogen and can provide for a saving of R454 in inorganic nitrogen fertilizer application. This equates to a 34% saving on inorganic nitrogen fertilizer application.

- ➢ These observations provide further support to the general management recommendations for the area, summarised below:

1. Ways in which to preserve and build soil carbon are important in this area (which has a high potential for loss of organic carbon):
    a. Mulching with weeds is very important in this system
    b. Mulching with cut grass or other organic matter if possible
    c. Ensuring canopy cover as early in the season as possible – thus close spacing
    d. Introducing a large diversity of crops as early as possible, especially legumes.
    e. Inclusion of manure in the system
2. Reduce synthetic fertilizers over time
3. Ensure legumes are a central component of cover crop and rotation options.
4. Cowpeas are an important inclusion in the intercropping process showing ability to increase organic C and N substantially in the short term.

Crop water productivity

Crop water productivity (CWP) or water use efficiency (WUE) relates to the amount of yield per unit of water used. It is an important measure of the impact of different practices on productivity in rain fed agricultural systems. Methods for improving CWP at field level include crop selection, planting methods, minimum tillage, nutrient management and improved drainage where appropriate. Average WP for maize is 1,2-2,3 kg/m^3 (FAO, 2003).

In this research process WP has been compared for different crops and crop combinations under CA.

The main variables used in calculating water productivity (WP) are yields and volume of water used to produce that particular yield. There are standard methods used in working out the yield (e.g. putting the harvested grain or biomass on a scale and weighing it, weighing a sample of cobs for maize and estimating yield using the plant population). The challenge is in determining the volume of water used to produce the yield. There are a couple of methods (simple and more complicated) used in determining the volume of water used.

In determining the water productivity, parameters (temperature, relative humanity, solar radiation, wind speed, wind direction to calculated ET_0) are required and these parameters are gathered from automatic weather stations. This information can be used to benchmark simpler methods used in the field, that farmers can be involved in. These ET_0 values are then multiplied by the crop coefficient to find the actual evapotranspiration (Etc), which is the volume of water used to produce the yield.

To calculate the ET_0, the equation below is used. The weather station calculates the reference evaporation ET_0 using the Penman Monteith equation shown below

$$ET_0 = \frac{0.408\Delta(R_n - G) + \gamma\frac{900}{T+273}u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)} \tag{1}$$

Where,

ET_0 reference evapotranspiration (mm/day),
R_n net radiation at the crop surface (MJ m^{-2} day^{-1}),
G soil heat flux density (MJ m^{-2} day^{-1}),
T air temperature at 2 m height (°C),
u_2 wind speed at 2 m height (m s^{-1}),
e_s saturation vapour pressure (kPa),
D slope vapour pressure curve (kPa °C^{-1}),
g psychrometric constant (kPa °C^{-1}),

Water productivity was calculated for three participants in Midlands (2020), Babhekile Nene, Fikile Maphumulo and Nomusa Shandu (All from Mayizekanye -MAY), who have been implementing CA for a period of 2 to 3 years. Water productivity for different CA cropping options was calculated for these participants, using both grain and biomass weights.

The options were a M-CA control (consecutively mono-cropped maize); M+CP-CA trial (maize and cowpea intercropped plot in a rotation system) and CA-M+B trial (maize and bean intercropped plot in a rotation system). The aim was to ascertain whether the different cropping options within the CA system provide for different water productivity outcomes. The results are shown in the figure below.

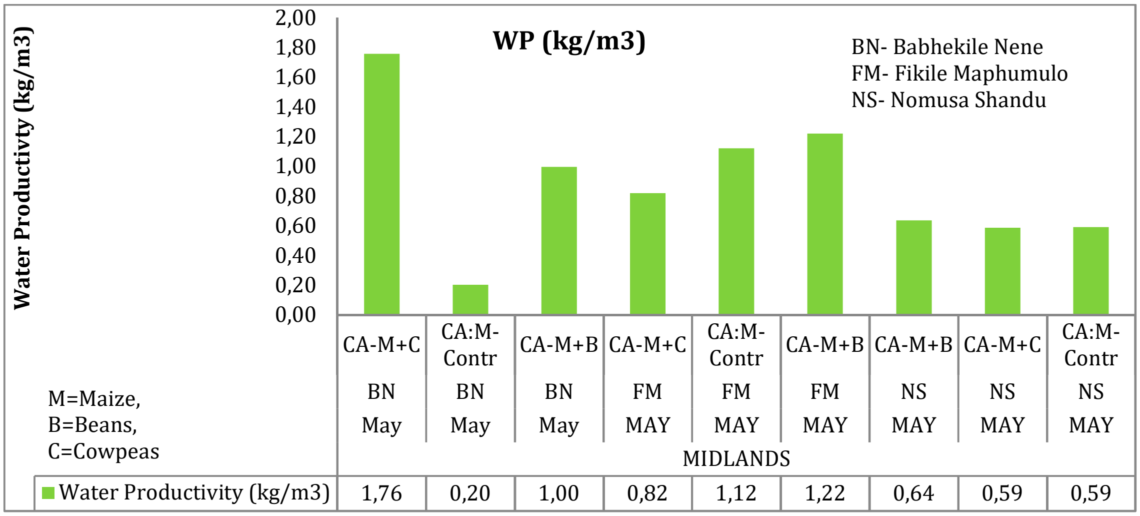
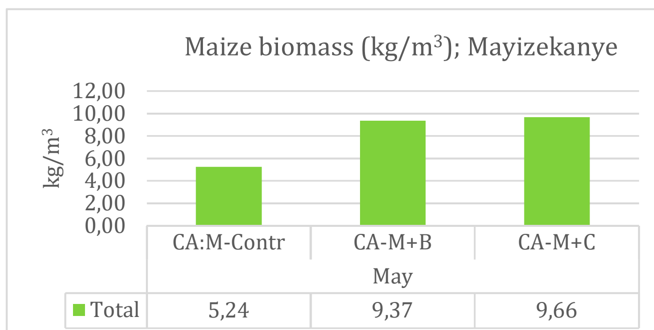


Figure 5: Water productivity for grain weight for 3 Midlands participants, 2020.

In all three cases the water productivity for grain production is higher for the CA maize and legume intercropped plots and more so for the maize and cowpea intercrops than the maize and bean intercrops, when compared to single cropped maize CA plots. This trend has been noted also in both the SKZN and Bergville sites and gives a clear indication of the advantages of intercropping with legumes that fix high levels of nitrogen and provide for good soil cover.

The CWP was also calculated for the above ground maize plant material, (stalks and leaves). The small figure alongside provides an average for the Midlands (3 participants rom Mayizekanye) for the 2019/20 cropping season. Here it is also clear that the water productivity for biomass production is much improved by the intercropping practice and specifically so for the maize and cowpea intercropped plots.



Progress per area of implementation

Impacts of COVID-19 on CA Participants

All the farmers visited were aware of the pandemic and had been affected in varying degrees:

- ✓ Some had not experienced any real effects of COVID-19 with respect to their personal lives as they were unemployed and dependent largely on farming to survive which had not been disrupted in a major way.
- ✓ CA proved to be quite beneficial during this season as many farmers used the beans and cowpeas as a supplementary source of food and managed to sell their maize to neighbours. Those who planted winter and summer cover crops, cut them and gave to their livestock, thus saving on feed.
- ✓ Most of those who produce for market were negatively affected as the lock down resulted in bakkie traders not coming into the community to purchase maize, hence it went dry in the

fields. The hardest hit area in this regard was Ozwathini. Mayizekanye farmers were mostly unaffected as their maize was ready for market just after level 5 lockdown was relaxed to level 4 and bakkie traders as well as street vendors were allowed to operate again.

- ✓ In terms of everyday life, many people had experienced restricted movement which affected them negatively as taxis were now available before 10 am and after 4 pm. During the day they had to use alternative means of transport.
- ✓ Acquiring agricultural inputs also proved to be a challenge due to lack of transport as well as the requirement of a permit/essential service certificate when travelling, which most participants did not have.
- ✓ In terms of food security, many households considered themselves fairly food secure, although there were concerns about the future if lockdown is extended. In Gobizembe, Mam Rita Ngobese and Mrs Mncanyana had already sold their maize from the CA plots to neighbours, which was a positive outcome of the lockdown as they normally use the maize purely for household consumption.

In summary, subsequent to the lockdown which took place from the 27th of March this year, the situation appeared quite bleak for our farmers in terms of their maize market as most businesses were not operating. However, as lockdown regulations eased and businesses slowly reopened, many farmers were able to sell their maize and found that the demand had even increased in some areas.

In terms of final yields, the majority of the farmers reported an increase in yield, which they measure through the amounts of income earned from sales, and amounts left over from selling surplus. Farmers commented that this is because CA allows them to plant closer together. Larger yield responses for their maize has also resulted from intercropping of maize with beans or cowpeas, both for new participants and for 'older' farmers who have been doing CA for 2-3 years. More than 80% of the farmers had sufficient maize to sell as well as consume with their families this season, meaning that their cropping systems served as a buffer against the rising food insecurity that is becoming more prevalent as a result of COVID 19.

MDF entered into a collaboration with a sister NGO, AFRA to provide fresh produce for food parcels for vulnerable families in the Umgungundlovu DM. Below is a snapshot of produce sold and incomes made through this process. Participants provided green maize, dry beans, avocadoes, pumpkins, sweet potatoes and leafy greens.

Figure 6: Some of the produce supplied by farmers to AFRA as well as locally

The table below provides an idea of maize (both from CA trial and control plots) sold in June 2020, indicating local sales and sales to AFRA. When it comes to beans, the locally popular varieties such as Ukulinga and Khakhi beans sold more than the PAN 9292 tried out in the CA trials.

Table 4*: **Summary table of maize and beans sold this season from 11 farmers in Swayimane: June 2020***

Name of Farmer	**Area**	**Maize sold locally (R30-35/doz)**		**Maize bought by Afra (R30-35/doz)**		**Beans bought by AFRA (Ukulinga/Khakhi Bean)**	
		Qty	Price	Qty	Price	Qty	Price
Babhekile Nene	Mayizekanye	17 dozen	R595,00			10 L	R200,00
Thembi Mkhize	Mayizekanye	15 dozen	R525,00				
Fikile Maphumulo	Mayizekanye	7 dozen	R245,00				
Nathaniel Myeza	Ozwathini	15 dozen	R525,00	5 dozen	R175,00		
Mrs Xulu	Ozwathini	28 dozen	R1 015,00			20 L	R525,00
Doris Chamane	Ozwathini						
Sbongile Mhlongo	Ozwathini	15 dozen	R450,00			20 L	R500,00
Macelu Bhengu	Ozwathini	18 dozen	R630,00	3 dozen	R105,00		
TOTAL			**R3 985,00**		**R280,00**		**R1 225,00**

Summary of yield measurements for Maize

For this season the average maize yield for the CA trial plots across all areas was 1,35 t/ha and that for the conventionally tilled controls was 0,99 t/ha. Although these yields are low and the average is in fact marginally lower than for the 2018/19 season (1,43 t/ha) all participants reported producing more maize and overall productivity has improved from the previous season. It is considered due to the difficulties of this season and most maize being harvested green, which necessitated a yield estimation process of counting the number of cobs (linked to weighing of selected cobs and grain only), has led to a considerable under-estimation of the actual yield. Yield data sheets are shown in Appendix 1 of this document

Ave yield (t/ha)	No of participants	Percentage participants
<1	10	11,8%
>1<2	38	44,7%
>2<4	34	40,0%
>4	3	3,5%

The small table alongside provides an assessment of the yield ranges within which farmers have fallen: 44,7% of the participants produced between 1 and 2 tons/ha of maize, a further 40% of participants produced between 2 and 4 t/ha of maize and 3,5% produced more than 4t/ha of maize.

The table below is a depiction of the total number of participants, varieties planted in each area, as well as the total number of participants for whom maize yields were collected.

Table 5: Summary of maize yield production and collection numbers in Midlands 2019/20

Area	No of CA trials 2019	No of CA trials 2020	Lime	Maize	Beans	Cowpea	Herbicide	Protect clothing	Yield collection nos.
Mayizekanye	24	43	Yes	PAN SC701	PAN 9292	Mixed Brown	Round Up/Gramoxone	No	24
Gobizembe	10	19	Yes	PAN] SC701	PAN 148	Mixed brown	Round Up	No	16
Cornfields	10	13	No	PAN 6479	PAN 9292	Mixed Brown	Gramoxone	Yes	5
Ozwathini	15	44	Yes (supplied by DARD)	PAN SC701	PAN 9292	Black eyed	Springbok (supplied by DARD)	No	20
Ntabamhlophe Loskop		45	Yes	PAN 53	PAN 148	Black eyed	Round Up	Yes	20
TOTAL	**59**	**164**							**85**

Estcourt

Villages in Estcourt include Cornfields, Ntabamhlophe and Loskop. For the latter two villages, yields were promising and many farmers expressed that planting under CA was not only an educational experience in terms of improving their farming practices, but they also had sufficient food for themselves and their families during the lockdown period. Some were able to even share with poor neighbours who were left in dire straits as a result of the pandemic. Cornfields farmers on the other hand a rather promising start to the season, but due to adverse weather conditions, flash floods, hail storms and livestock invasions, only 6 of the 13 participants harvested their crops. These 6 participants re-planted their trials. The average yield this season for Cornfields was 1,938 t/ha compared to 1, 99 t/ha in the 2018/19 growing season, meaning there was no significant change in terms of yields in the current season.

CORNFIELDS MAIZE YIELDS 2020						
Name	**Surname**	**Treatment**	**No of Bags**	**Grain weight (kg)**	**area (m2)**	**weight (t/ha)**
Gabi	Ngcobo	Trial	2	25,240	200	1,262
Moses	Chonco	Trial	1	11,214	400	0,280
Gwaja	Khumalo	Trial	1	22,755	100	2,276
Petros	Khumalo	Trial		98,880	300	3,296
Jabulile	Mdletshe	Trial	2	25,240	250	1,010
Mbuso	Mkhize	Trial	3	37,860	250	1,514
Average Yield Trial						**1,928**

Figure 7: (from left) Mbuso Mkhize's maize, (centre) Gwaja Khumalo' Maize was already mixed, (right) Moses Chonco's maize grain

Maize quality was reduced by heat and pest attacks (including rats and locusts). Maize performed quite well in Ntabamhlophe (ave 1,5 t/ha max 6,3t/ha) Ntabmhlophe and Loskop (ave 1,1t/ha; max 3,7t/ha, There was significant variability in terms of yield, with most participants ranging between 2 and 4 t/ha. None of the participants in the two aforementioned areas have controls as they all have small plots of land on which to plant.

Figure 8: (left) Nphtali Mngadi's CA maize, (center) Mrs Xulu had already de-cobbed her maize, (right) Lindiwe Ntshalintshali 's Maize Grain

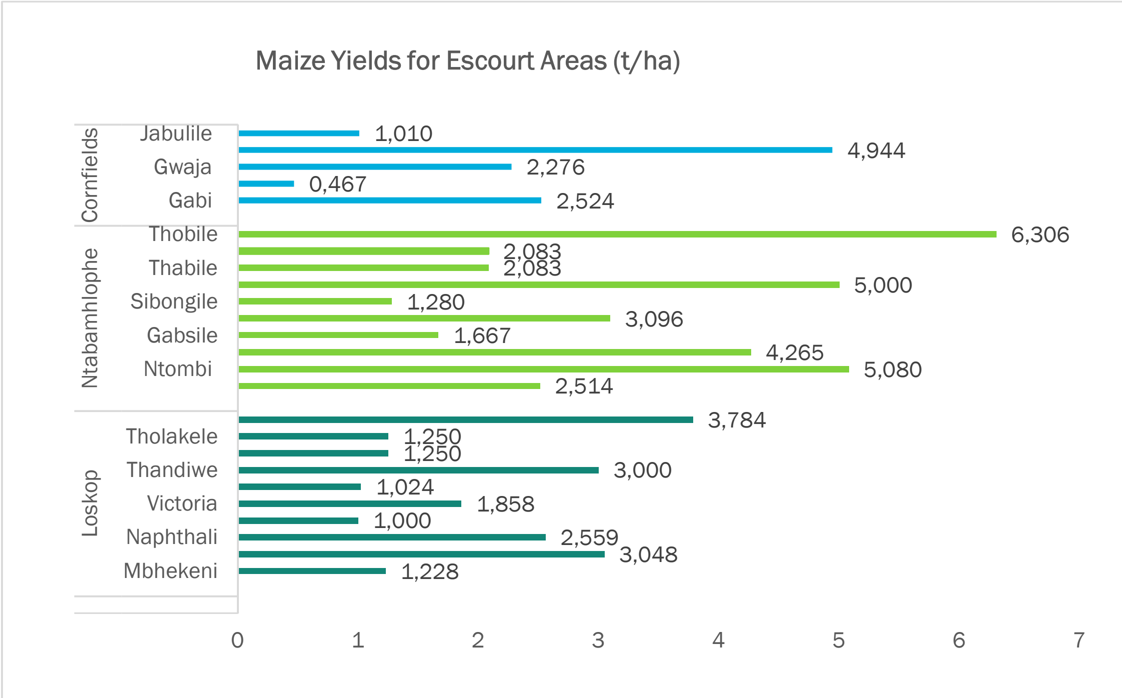


Figure 9: Maize yields for CA trial participants in the Estcourt villages; 2019/20

uMshwathi Maize Yields

uMshwathi is one of the 7 local Municipalities under uMgungundlovu DM and within this municipality work is undertaken in 8 villages: Swedi, Bamshela, Hlathikhulu, Emathulini in Ozwathini and Gobizembe, Mayizekanye1,2,3 in Swayimane. This season, there has been a significant improvement in terms of maize sales and overall production compared to the previous season. This can be attributed to good summer rains as well as the CA system which incorporates closer spacing with intercropping improved soil water retention and improved soil health. CA trial plots had a higher average yield (1,35t/ha) than the conventionally tilled control plots (0,99t/ha). Although the trials had a higher average than the control plots, the overall yields are still very low as the financial break-even point for maize is 4 t/ha. Only three farmers managed to reach the break-even point in terms of their yields and only on their CA plots.

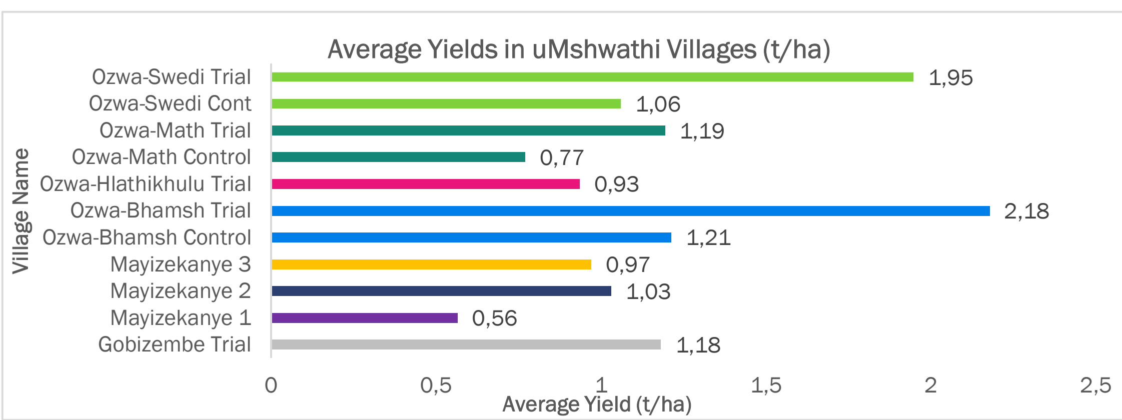


Figure 10: Maize yields for CA trial participants in the Umshwathi villages; 2019/20

Maize Production Income

When stage 5 lockdown was implemented in March, most of the farmers said the demand for maize dropped drastically. This was especially the case for Ozwathini farmers whose maize was ready around the beginning of April. Mayizekanye farmers were lucky as their maize was ready by May, when lockdown level 5 had been relaxed and bakkie traders became active again and local demand was much higher than usual. Out of the 55 farmers whose yields were collected in Ozwathini, Gobizembe and Mayizekanye, **the combined total income for green mealies sold from their CA trials was R 32 164 compared to R 8 395 in the 2018/19 growing season. The total recorded income from the control plots across the same number of farmers in the three areas was R 38 155. The combined income from the trial and control plots translate to an average of R 1278.50 /farmer which is equivalent to a standard pension grant.**

This local success is likely to increase the adoption rate of the CA approach substantially in the area, as farmers have now realised improved yields and improved maize quality in these plots, when compared to their conventional practices. The additional environmental benefits are slowly becoming better appreciated.

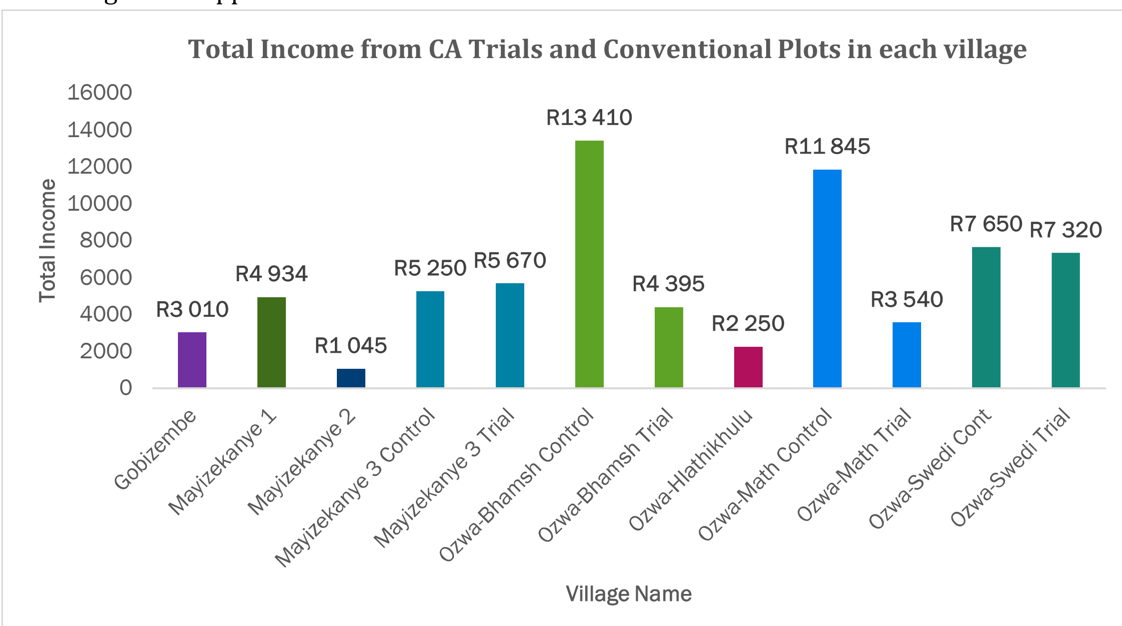


Figure 11: Incomes realized from sale of green mealies in the Umshwathi villages between May and July 2020

Short season maize and late planting

Despite introduction of the short season maize varieties only 2 participants planted these varieties, very late and without a high level of care, resulting in extremely low yields of around 0,76t/ha. Very late planting of short season maize was not a good strategy for these farmers.

Zinhle Cebekhulu (shown on the right) from Swayimane decided to plant in the middle of March,and planted the maize (SC701) and bean intercrop. Surprisingly both her maize and beans grew and yielded well, which indicates that late plantings can be attempted with the standard varieties, rather than using the more specialised short season varieties.

Case study: Rita Ngobese

Rita Ngobese is a dedicated farmer, who unfortunately has had challenges with growing maize since her first year in the program. Her maize plots are situated just below a line of avocado trees, which resulted in the maize growing very thin stalks and producing tiny cobs. In the previous season, she moved her CA plot a bit further down and rotated maize and cowpeas with maize and beans and vice versa. Furthermore, subsequent to harvesting maize she planted winter cover crops in between the rows and on an adjacent plot, mainly to provide feed for her young goats. For the first time this season, her maize cobs appeared significantly larger in size compared to when she first planted, which may be attributed to a number of factors such as good rainfall and the incorporation of the cover crops, which helped to improve her soil organic matter.

Figure 12: Rita Ngobese Maize yield, (left) trial maize from previous season, (right) trial maize from current season

Summary of yields for beans and legumes

Weighing of legumes was completed around the end of June across all areas. Cowpeas did not do well at all this season in all areas except for Loskop, where a handful of farmers managed to get some yield, although still very low. Beans performed quite well in most of the areas, with most farmers getting yields between 10 and 20 kg and some obtaining 50 kg in Ntabamhlophe/Loskop. Overall this has been a good season, as farmers were also able to sell the beans on top of using them for household consumption. It was quite encouraging to see the most farmers took the effort to do intercropping, despite some having reservations about it leading to competition between the maize and beans.

Figure 13: Mawthi Chonco planted potatoes next to beans and they all succumbed to late blight (l and c), Thukukani Mthembu's cowpea plot (r), also affected by blight

In terms of estimated yields/ha, Ozwathini had the highest average yield/ha which was 1.32 t/ha and Gobizembe had the lowest which was 0.26 t/ha. This was most probably because they had an outbreak of blight this year, which completely damaged cowpeas and potatoes as well as beans, as some farmers had planted these close together.

The small figure alongside shows the average bean yields for the CA trials in the Midlands villages

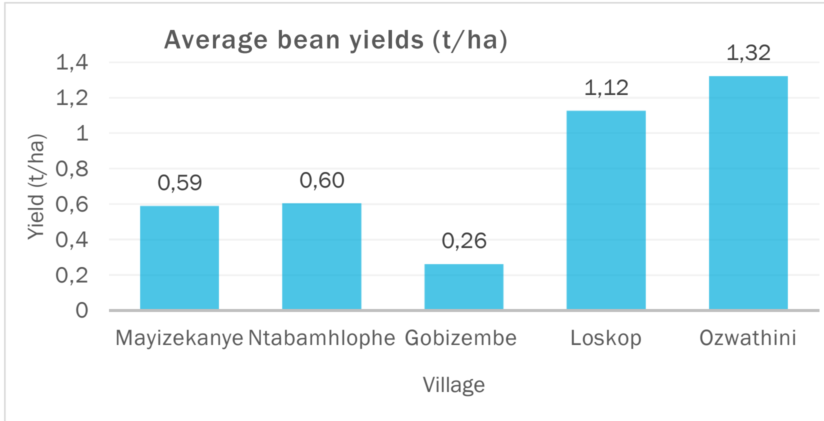


Figure 14: Average bean yields for CA trials for Midlands areas; 2019/20

This season, black eyed cowpeas were tried out, instead of the usual mixed brown. This variety appears to be much more susceptible to blight and other fungal diseases and very few participants received a yield. Similarly, participants were not impressed by the production of the PAN9292 beans provided and much prefer the Gadra and Ukulinga varieties tried out in the past.

Figure 15: Clockwise from the top, 1. Babhekile Nene from Mayizekanye, 2. Mrs Chamane was still busy with depodding, got 20 kg beans from her trial 3. Mrs Mhlongo's beans looked very nice (Ozwathini), Mr Myeza with his beans and cowpeas (Ozwathini)

Ntombencane Gasa case study

Ntombencane Gasa is a 66 years old pensioner who lives with her grandchildren. Farming is one of her activities. She also has a small vegetable garden and she likes trying out new crops to see if they will grow or not. She planted a range of cover crops.

Yields:

Sunflower: 0.6 kg
Mungbeans: 1.5 kg
Sorghum: 1.2 kg

Figure 16: Mama Ntombencane Gasa and her harvested crops

Cover crops

Generally, farmers are a bit reluctant to grow crops that they cannot eat themselves. Summer cover crops (Sun hemp, millet and sunflower) were planted by 20 participants across Swayimne and Ozwathini. These grew well but farmers lost focus during lockdown and either neglected these plots or fed their livestock using a cut and carry system. It was thus not possible to harvest seed form these plots, as was the intention.

Figure 17:SCC plots in Gobizembe: Khanyisile Xaba did not weed and SCC were over-run (L), Flomina Mkhize's SCC plot grew and produced reasonably well, but she did not harvest seed. In Ozwathini Thembeni Mkhize intercropped one of her maize plots with SCC (R)

Mr Miyeza in Ozwathini experimented with both SCC and WCC (fodder rye, black oats and fodder radish) and intercropped these in both cases with his maize. Having seen the results and now having supplementary fodder for his 10 cattle and 13 goats, he is enthused to grow larger areas of cover crops as fodder in the future.

Figure 18:Above left: Mr Mieza's intercropped plots of maize with SCC, Above center: his WCC and Above right; the fodder radish which he harvested and kept aside, to feed in small regular amounts to his livestock

Ozwathini Fodder Experimentation Workshops

Introduction

Between the 13th and the 26th of May, a series of workshops were conducted in Ozwathini on fodder experimentation. The workshops were run by Brigid Letty (a livestock specialist from the INR), with Tema as the translator and Ntokozo as the recorder. The purpose of the workshops was to equip farmers with basic knowledge on winter supplementation, hay making, disease control as well as calf rearing. Due to lockdown restrictions, Brigid was unable to join the team in Ozwathini and the workshop was run using the Zoom App. It was an interesting approach as it was the first time we had hosted an online meeting, but it went fairly smoothly. One of the benefits of using Zoom was that it allows for sharing of information and when people have questions you can easily research and share during the meeting. However, network was a problem on the first day, which made it slightly challenging to run the workshop, especially in the first hour.

Community meetings and farmers days have largely come to a halt since the pandemic broke out but an exception was made in this regard as farmers were really keen to attend the workshop. The team ensured that all regulations were followed; including getting a permission letter form the local police station. Farmers were informed in advance that they were required to wear face masks and all chairs were sanitized on arrival at the meeting. Each farmer was given a bottle of hand soap to take home and everyone sanitized their hands upon arrival, each time they went out and came back and upon departure at the end of the meeting. Chairs were placed just over 1 metre apart. Instead of sandwiches, which would require handling, only fruits and biscuits were provided as refreshments after the meeting.

Figure 19: Zoom Meeting on Winter Supplementation, run by Brigid Letty

Workshop 1: Winter Feed Supplementation


Introduction

The meeting opened with a discussion on whether farmers provide supplements for their livestock in winter, and also what are the most common challenges. Responses given were:

- Grazing grass dries up in winter, leaving livestock with little to no food.
- Some farmers cut maize stover for their cattle in the evenings but it runs out before winter season ends
- Ingongoni grass is the most dominant and is not very palatable for cattle
- Cows are susceptible to diseases when pregnant due to insufficient nutritious grass
- Higher disease prevalence and mortality rate due to loss of body condition

To help mitigate the negative effects of winter season, one farmer shared that he normally feeds his cattle amaranthus and black jack leaves in winter, together with the maize stover. This season he planted WCC and SCC with MDF and has started cutting some for his cattle, and believes the cover crops will help a lot in getting his cattle through winter.

Figure 20: Bab Myeza's wcc (left), scc (center and right) which he cuts to give to his cattle

Farmers were asked what happens when a cow becomes too thin and they explained that it becomes susceptible to diseases, there is increased mortality especially in pregnant cows and they become less productive, i.e. have fertility issues. Brigid then explained that the reason why grasses become less nutritious in winter is because when winter starts, they transfer all their nutrients to the roots before drying out, thus leaving mainly dead fibre above the ground. She also explained body condition score and how farmers can assess whether their cars are in good condition or not. Between a scale of 1-5, the farmers unanimously agreed that by August, their cows normally have a BCS (body condition score) of 1, meaning all of their ribs show and they have large hollow spaces on their tail bone. A body condition score of one is very dangerous as it means the cow is severely undernourished.

The primary lessons from this workshop were:

- Supplementation is important as it aids in providing nutrients and energy and also improving the palatability of hay/straws and also improves grazing.
- There are various products on the market which can be used for supplementation, such as premix 450, a protein block and molasses,
- Molasses provide energy, some vitamins but has no urea, thus cattle will need an additional

WINTER SUPPLEMENTATION EXPERIMENTATION OPTIONS					
	Name of Farmer	**Protein block**	**Premix 450**	**Molasses**	**Hay**
1	NN Myeza		X	X	
2	Sphiwe Ngubane	X	X		
3	Mbongeni Mhlongo		X	X	
4	Mrs Hlophe		X	X	
5	Velaphi Mkhize	X		X	Bale
6	Lindiwe Khanyile		X	X	Bale
7	Bheki Mathobela	X	X		
8	Amose Zondi		X	X	Bale
9	Thandekile Ndimande		X	X	Bale

supplement.

- Premix 450 and the protein block both contain urea, and are a source of protein. However, urea can be harmful and even fatal to cattle when taken in large amounts. Mr Mkhize from Montobello testified to this as he lost one of his calves after it helped itself to an open bag of urea that had been left uncovered.
- Measurement: 1 cup of premix 450/cow, 1 cup of molasses/cow and make a protein block available by placing on an iron sheet and allowing cattle to lick it. One protein block is sufficient for 10 cows.
- Supplements are not a substitute for feed by merely help provide nutrients that make be lacking in grass or hay, therefore provide hay or allow cattle to graze.

Most of the farmers said that they do not supplement but give their cattle maize stalks and they purchase bales when necessary. Some have had challenges with regards to buying bales in that the grass is sometimes of such a poor quality, the cattle struggle to eat it. The farmers agreed to do an experiment on the effect of supplementation on body condition score. Each farmer will record how much supplement they give and to how many cattle and write down the body condition score at the beginning as well as at the end of winter. Recording will be done to include supplement used, number of cows fed, period of supplementation and the body condition score before and after supplementation.

Summary of fodder supplementation experimentation in Ozwathini

The table below summarizes the supplementation experimentation undertaken by 6 participants from Ozwahtini

Table 6: Summary of fodder supplementation experimentation In Ozwathini June to August 2020

Name and Surname	Activity	Description	Comments
Mr Mathobela	Premix 450 Protein block	Still to do 1x protein block; 3weeks	8 cattle. BCS changed from 2 to 3
Mr Zondi	Premix 450 Molasses Hay bales	1x50kg; 3,5 weeks Provided separately to one sick cows	2 cattle- enjoy this Sick cow has now recovered
Mrs Hlophe	Premix 450 Molasses Hay bales	1kg premix x 3 1L molasses and 1 bales of hay per day	2 cattle, 2 grown calves They stopped eating the premix and preferred bales with molasses. More bales are to be prepare
Mr Ngubane	Protein block Premix 450 Molasses Hay bales	1 cup molasses per cow with a large bale of hay, which lasted a month	4 cattle – they did not like the protein block and hay with molasses is preferred. More will be prepared.
Mrs Thandiwe Nzimande	Premix 450 Molasses Hay bales Grazing on WCC	2cups premix, 2 cups molasses and hay every morning and grazing stover and remained of WCC plot 1x50kg premix; 3 weeks	1 calf orphaned at 3 months, now 1 year old. Calf now weighs 450kg. It is small for its age, is always eating and often constipated. BCS from 1 to 2
Mr Mkhize	Protein block Premix 450 Molasses Hay bales Suromel (w spoon of bicarb)	2 blocks per month provided throughout the year 4x50kg animal feed mixed with 1x50kf premix 450 per month in winter	46 cattle and 3 calves Calf fed for 2months, recovered well from initial diarrhoea, but is small for its age

Figure 21: Above left: Mrs Nzimande's 1 year old calf, fed on premix, molasses, hay and WCC stove, Center Mr Mkhize measuring the calf with a weighing band to estimate it's weight and Above Righ;t the 2 month old calf

Workshop 2: Diseases and Parasites

Introduction

Workshop 2 focused mainly on controlling internal and external parasites where emphasis was placed on that farmers must ensure that their cattle are vaccinated regularly. When asked about the most common parasites and diseases they struggle with in livestock, these were the responses:

- Tapeworm and roundworm
- Ticks
- Heart water (grey tick, mostly in hot temperatures)
- Red water
- Lumpy skin
- Scours

The farmers were advised to always have Lectade, Terramycin and Maxitet, especially for young livestock as they tend to be more susceptible. Vaccination was also recommended against brucellosis, black quarter, and lumpy skin. Regular deworming of calves was also said to be essential. For tickborne diseases (heartwater and red water), farmers were advised to use Terramycin for the former and Berenil for the latter.

A question was asked about how to control amathuku (worms) often seen on the head of goats which causes them to go mad and run around in circles. Brigid explained that the worm is spread by dogs and is dangerous for goats as they normally die from it. It can be prevented by throwing away goat heads after slaughter instead of giving it to dogs as that is how the diseases stays in cycle.

Important points that farmers have to remember:

- Always vaccinate cows for vibriosis, especially when they graze on communal land and mix with other herds, because if mounted by an infected bull it may lead to fertility issues
- Always use recommended dosage on medication, no more and no less than that
- Separate sick cows from the herd to prevent spread
- Always ensure that cows have access to good grazing grass or provide supplements as proper nutrition will minimize the risk of diseases
- Use tick grease as a spot treatment for ticks. Important to control ticks, because they can cause damage to the skin apart from transmitting diseases.

- Proper handling of all medical equipment is highly important, sterilise all containers prior to use and confiscate vaccines that have already been open
- Vaccines must be stored under cold temperatures, if travelling by taxi, and you don't have a fridge, carry a cooler box with ice and first ensure that your cattle are close by so that when you return you can vaccinate immediately.

Figure 22: Farmers must always have the above at home, to treat bacterial infections and scours, as delayed treatment may lead to premature death

Practical Demonstration

At the end of the workshop, there was a practical demonstration of the baler, which the farmers found to be quite interesting. The process was fairly easy and straightforward, as the grass had already been collected. A string was placed on the two grooves at the top and ran down the bottom and brought out of the two front slits, thereafter the container was stacked with grass which was then pressed down and stacked some more and pressed until full. The string was then used to tie the bale and it was weighed afterwards. A total of four bales were made, which weighed between 7 to 9 kg. The courser and harder the grass, the harder it was to stack closely, hence the lighter weight. Finer grass such as kikuyu worked well as it was easy to stack and form into a ball, and also weighed more as there were less air spaces. The pictures on the following page show the demonstration process.

Figure 23: A range of pictures outlining the baling workshop, showing the grass, the baler, and completed bales.

Workshop 3: Calf Management

Figure 24: Right: Mr Sikhakhane's calves, grazing in his SCC plot.

Introduction

At the first workshop, it emerged that the majority of farmers were fairly new to livestock ownership. They bought calves in March and were unsure about some of the important things to consider when rearing calves. Some had a challenge with feed, as their calves tended to be picky when it came to super 18 feed, and also frequently had diarrhoea, with some fatalities. Having taken all of the aforementioned into consideration, Brigid and the MDF team decided to run a workshop on calf management.

Primary lessons from the workshop were as follows:

- Calves need to get plenty of colostrum between 24 hours and up to 3 days after birth
- It is important to supply the right feed, as certain feed types contain fifth grade urea which may be harmful to calves.
- In terms of feeding, buy a milk replacement and give to calve twice a day. For Suromel, normally its 200g in the morning and 200 g in the evening in one litre of water and a bag of 25 kg lasts for 55 days.
- Deworm calves regularly and vaccinate female calves against CA, between 4 and 8 months.
- In case of scours, stop giving milk and give either Lectade or glucose together with Terramycin which will kill the infection.

Below is a short table on basic calf management (shared by Mr Mkhize, the KZNDARD extension officer)

Age	Feed Type	Health Care
1 week	Jersey 1 litre milk (morning) 1 litre milk (evening) Angus x 2	
2 weeks	2 litre milk (morning) 2 litre milk (evening)	
3 weeks	2 litre milk (morning) 2 litre milk (evening) + calf meal	
1-2 months	2 litre milk (morning) 2 litre milk (evening) + calf meal + hay	Deworm for tapeworm and round worm.Apply spot treatment for ticks (tick grease/super dip)
3 months	Gradually decrease amount of milk 1 litre milk (morning) 1 litre milk (evening) + calf meal + sweet feed	
4 months	Sweet feed, start supplementing Premix 450 Protein block Molasses	Vaccinate for Brucellosis, clostridium and vibriosis

Farmers asked for assistance with buying more calves and paid a total of R 19 650 to procure them.

Conclusion

Overall, the workshops went well, with some challenging questions and points of reflection in between. The farmers were very pleased and said they gained a lot and what they learned would be useful in taken them forward.

Procurement of Calves

Between June and August farmers have bought three sets of calves, one from Estcourt and two Creighton. The three sets of calves were procured with Brigid's assistance, who linked the farmers with commercial farmers who sell calves. The calves bought were different mixed breeds, which included Holstein and Inguni, Holstein and Angus and other breeds. The calves cost between R 300 and R850 each, with the ones from Escourt being the most expensive. The farmers raised R 11 400 for the first set of 10 calves at R850 each, and then another R 2400 for 8 calves at R 300 each and finally R 5 850 for 13 calves at R 450 each which were procured from Creighton. A Whatsapp group was opened by Tema and Brigid as a platform for farmers to share updates on how their calves are doing. Some of the pictures below come from this group. The calves have adjusted very well and are healthy and growing, with the farmers being very grateful to Brigid and MDF for their support in both acquiring and looking after the calves. This has meant that there has only been one fatality and all other calves are now doing well. The reason for buying calves is because the farmers want to venture into livestock farming and raise cattle to sell for ceremonies such as weddings and also for dowry payments. In addition, cattle are seen as a symbol of wealth and success in the African culture.

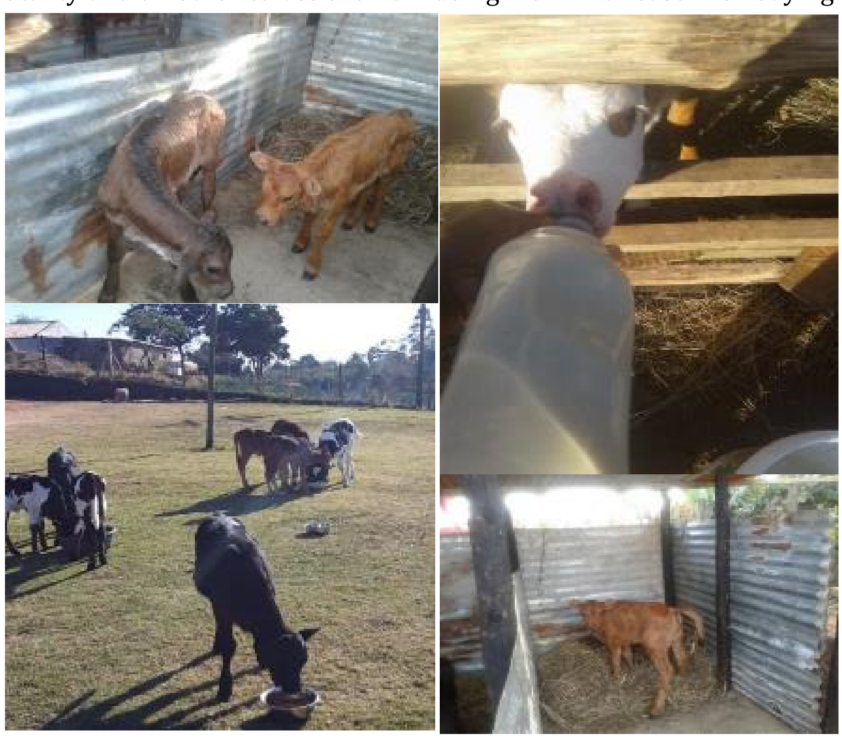


Figure 25: From top left, Mam Xulu, Bab Ngcobo and Bab Skhakhane's calves

Farmer Innovation Platforms

Two events were held towards the end of 2019, one in Ozwathini focussing on cover crops and one in Ntabamhlophe in association with LandCare as an introduction to CA in the area. The annual farmers' days could not be held due to the COVID-19 pandemic, but a further 3 learning and stakeholder engagement workshops related to crop-livestock integration were held in Ozwathini in may and June 2020. In addition, Temakholo Mathebula has given presentations in two webinars, outlining and promoting the CA SFIP:

1. "Heal the Land, heal the people," national webinar hosted by the Integra trust on the 6th of June 2020 and

2. "The gendered impacts of COVID-19: Women in informal work", national webinar hosted by PLAAS at UWC on the 6th August 2020.

References

Critchley, W., & Siegert, K. (1991). *Water harvesting (AGL/MISC/17/91). A Manual for the Design and Construction of Water Harvesting Schemes for Plant Production.* Rome: FAO.

Dlamini, P., Jewitt, G., Lorenz, S., & Orchard, C. (2011). Controlling factors of sheet erosion under degraded grasslands in the sloping lands of KwaZulu-Natal, South Africa. *Agricultural Water Management, 98 (11)*, 1711-1718. doi:10.1016/j.agwat.2010.07.016

FAO. (2003). *Unlocking the Water Potential of Agriculture.* Retrieved from http://www.fao.org/3/y4525e/y4525e00.htm#Contents

Mutema, M., Jewitt, G., Chivenge, P., & Kusangaya, S. (2017). Spatial scale impact on daily surface water and sediment fluxes in Thukela river, South Africa. Retrieved from https://www.researchgate.net/publication/309720071

Schulze, R. E. (2011). *A 2011 Perspective on Climate Change and the South AfricanWater Sector. Report TT 518/12.* Pretoria, RSA.: Water Research Commission.

Stolbovoy, V., Montanarella, L., Filippi, N., Jones, A., Gallego, J., & Grassi, G. (2007). *Soil sampling protocol to certify the changes of organic carbon stock in minteral soil of the European Union. Version 2.* Luxembourg. ISBN: 978-92-79-05379-5: EUR 21576 EN/2. 56 pp. Office for Official Publications of the European Communities.

Appendix 1: Maize yield data for the Midlands villages; 2019/20

AREA	Name	Surname	Treatment	No of Cobs	No of Bags	Av. weight (kg)/bag	Av. Weight of cob	Av. weight of grain	weight of cob + grain	%grain weight	Grain weight (kg)	area (m2)	Weight (t)	weight (t/ha)	Income (total dozens) (R)
	Mavis Shezi	Nkomo	Trial	200	2	22,594	0,084	0,173	0,258	0,673	30,398	400	0,030	0,760	R0,00
	Bongiwe	Shezi	Trial	300	3	22,594	0,084	0,173	0,258	0,673	45,597	400	0,046	1,140	R800,00
	Thandazile	Maduna	Trial	240	2,4	22,594	0,084	0,173	0,258	0,673	36,478	400	0,036	0,912	R300,00
	Dudu	Shezi	Trial	480	4,8	22,594	0,084	0,173	0,258	0,673	72,956	400	0,073	1,824	R240,00
	Ntombi	Shandu	Trial	600	6	22,594	0,084	0,173	0,258	0,673	91,194	400	0,091	2,280	R0,00
	Nomusa	Shandu	Trial	300	3	22,594	0,084	0,173	0,258	0,673	45,597	600	0,046	0,760	R750,00
	Fikile	Maphumulo	Trial	0	0	22,594	0,084	0,173	0,258	0,673	0,000	400	0,000	0,000	R600,00
	Lungile	Phungula	Trial	360	3,6	22,594	0,084	0,173	0,258	0,673	54,717	400	0,055	1,368	R1 200,00
	Sbongile	Nene	Trial	0	0	0	0	0	0	0	0,000	400	0,000	0,000	R0,00
	Sbongile	Zondi	Trial	0	0	0	0	0	0	0	0,000	0	0,000	0,000	R0,00
	Lindeni	Nkala	Trial	444	4,44	22,594	0,084	0,173	0,258	0,673	67,484	400	0,067	1,687	R444,00
	Agnes	Gabela	Trial	240	2,4	22,594	0,084	0,173	0,258	0,673	36,478	800	0,036	0,456	R300,00
	Ntmobikhona	Mchunu	Trial	0	0	0	0	0	0	0	0,000	400	0,000	0,000	R0,00
	Philile	Mthethwa	Trial	60	0,6	22,594	0,084	0,173	0,258	0,673	9,119	0	0,009	0,000	R240,00
	Bab	Shangase	Trial	12	0,12	22,594	0,084	0,173	0,258	0,673	1,824	300	0,002	0,061	R60,00
	Mrs Msomi	Ndokweni	Trial	36	0,36	22,594	0,084	0,173	0,258	0,673	5,472	400	0,005	0,137	R0,00
	Total (Trial):													**5,639**	
Mayizekanye 1	**Average Yield Trial**													**0,564**	**R4 934,000**
	Name	**Surname**	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**%grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**	**Income (total dozens) (R)**

	Nakeni	Ngubane	Trial	804	8	22,594	0,084	0,173	0,258	0,673	121,593	400	0,122	3,040	R800,00
	MaNene	Mkhize	Trial	240	2,4	22,594	0,084	0,173	0,258	0,673	65,373	400	0,065	1,634	R600,00
	Fikile	Maphumulo	Trial	284	2,84	22,594	0,084	0,173	0,258	0,673	43,165	400	0,043	1,079	R245,00
	Sbongile	Ndlovu	Trial	288	3	22,594	0,084	0,173	0,258	0,673	45,597	400	0,046	1,140	R2 100,00
	Total (Trial):													**4,119**	**R1 045,000**
Mayizekanye 2	**Average Yield Trial**													**1,030**	
	Name	**Surname**	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**%grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**	**Income (total dozens) (R)**
	Babhekile	Nene	Trial	420	4,2	22,594	0,084	0,173	0,258	0,673	63,836	400	0,064	1,596	R420,00
			Control	1080	10,8	22,594	0,084	0,173	0,258	0,673	164,150	600	0,164	2,736	R3 150,00
	Dumazile	Nxusa	Trial	1800	18	22,594	0,084	0,173	0,258	0,673	273,583	1200	0,274	2,280	R5 250,00
			Control	720	7,2	22,594	0,084	0,173	0,258	0,673	109,433	800	0,109	1,368	R2 100,00
	Total (Trial):													**3,876**	**R5 670,000**
Mayizekanye 3	**Average Yield Trial**													**0,969**	**R5 250,00**
	Name	**Surname**	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**%grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**	**Income (total dozens) (R)**
	Doris	Chamane	Trial	720	7,2	22,594	0,024	0,173	0,198	0,877	142,651	400	0,143	3,566	R1 800,00
			Control	1800	18	22,594	0,024	0,173	0,198	0,877	356,627	2000	0,357	1,783	R6 000,00
	Sibongile	Mhlongo	Trial	360	3,6	22,594	0,024	0,173	0,198	0,877	71,325	400	0,071	1,783	R450,00
			Control	800	8	22,594	0,024	0,173	0,198	0,877	158,501	1000	0,159	1,585	R2 345,00
	Macelu	Bhengu	Trial	105	1,05	22,594	0,024	0,173	0,198	0,877	20,803	400	0,021	0,520	R90,00
			Control	250	2,5	22,594	0,024	0,173	0,198	0,877	49,532	600	0,050	0,826	R0,00
	Joice	Makhoba	Trial	500	5	22,594	0,024	0,173	0,198	0,877	99,063	400	0,099	2,477	R1 200,00

	Name	Surname	Treatment	No of Cobs	No of Bags	Av. weight (kg)/bag	Av. Weight of cob	Av. weight of grain	weight of cob + grain	%grain weight	Grain weight (kg)	area (m2)	Weight (t)	weight (t/ha)	Income (total dozens (R)
			Control	1200	12	22,594	0,024	0,173	0,198	0,877	237,751	2000	0,238	1,189	R3 500,00
	Total (Trial):													**8,346**	**R3 540,000**
	Total (Control):													**5,382**	**R11 845,000**
Ozwa-Math Trial	**Average Yield Trial**													**1,192**	**R15 385,000**
Ozwa-Math Control	**Average Yield Control**													**0,769**	
	Name	**Surname**	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**%grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**	**Income (total dozens (R)**
	Thembi	Mkhize	Trial	180	6	22,594	0,024	0,173	0,198	0,877	118,876	400	0,119	2,972	R1 800,00
			Control	1800	18	22,594	0,024	0,173	0,198	0,877	356,627	2000	0,357	1,783	R0,00
	Nice	Maize	Trial	360	3,6	22,594	0,024	0,173	0,198	0,877	71,325	400	0,071	1,783	R450,00
			Control	0	0	22,594	0,024	0,173	0,198	0,877	0,000	1000	0,000	0,000	R0,00
	Bab	Zondi	Trial	0	0	22,594	0,024	0,173	0,198	0,877	0,000	400	0,000	0,000	R0,00
			Control		0	0,000	0,000	0,000	0,000	0,000	0,000	400	0,000	0,000	R0,00
	Total (Trial):													**4,755**	**R2 250,000**
	Total (Control):													**1,783**	**R0,000**
Ozwa-Hlathikhulu Trial	**Average Yield Trial**													**0,679**	**R2 250,000**
Ozwa-Hlathikhulu Trial	**Average Yield Control**													**0,255**	
	Name	**Surname**	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**%grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**	**Income (total dozens) (R)**
	Selaphi	Mthuli	Trial	840	8,4	22,594	0,024	0,173	0,198	0,877	166,426	400	0,166	4,161	R2 100,00
			Control	960	9,6	22,594	0,024	0,173	0,198	0,877	190,201	1000	0,190	1,902	R2 400,00
	Nokuthula	Sibiya	Trial	150	5	22,594	0,024	0,173	0,198	0,877	99,063	400	0,099	2,477	R450,00

		Control	2400	24	22,594	0,024	0,173	0,198	0,877	475,503	5000	0,476	0,951	R6 000,00
Mnto	Mthuli	Trial	180	1,8	22,594	0,024	0,173	0,198	0,877	35,663	400	0,036	0,892	R450,00
		Control	804	8,04	22,594	0,024	0,173	0,198	0,877	159,293	600	0,159	2,655	R2 010,00
Euginia	Ndimande	Trial	192	4	22,594	0,024	0,173	0,198	0,877	79,250	400	0,079	1,981	R480,00
		Control	0	0	0,000	0,024	0,000	0,024	0,000	0,000	400	0,000	0,000	R0,00
Lindiwe	Khanyile	Trial	96	0,96	22,594	0,024	0,173	0,198	0,877	19,020	400	0,019	0,476	R240,00
		Control	0	0	22,594	0,024	0,000	0,000	0,000	0,000	0	0,000	0,000	R0,00
Lina	Mthuli	Trial	180	10	22,594	0,024	0,173	0,198	0,877	198,126	400	0,198	4,953	R525,00
		Control	1200	12	22,594	0,024	0,173	0,198	0,877	237,751	800	0,238	2,972	R3 000,00
Jane	Ngcobo	Trial	60	0,6	22,594	0,024	0,173	0,198	0,877	11,888	400	0,012	0,297	R150,00
		Control	0	0	22,594	0,024	0,173	0,198	0,877	0,000	0	0,000	0,000	R0,00
Total (Trial):													**15,236**	**R4 395,000**
Total (Control):													**8,480**	**R13 410,000**
Average Yield Trial													**2,177**	**R627,857**
Average Yield Control													**1,211**	**1915,714**

Ozwa-Bhamsh Trial
Ozwa-Bhamsh Control

Name	**Surname**	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**% grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**	**Income (R)**
Bab	Nkomo	Trial	936	9,36	28,105	0,024	0,173	0,198	0,877	230,679	400	0,231	5,767	R2 340,00
		Control	720	7,2	22,594	0,024	0,173	0,198	0,877	142,651	400	0,143	3,566	R1 800,00
Elina	Zondi	Trial	792	7,92	22,594	0,024	0,173	0,198	0,877	156,916	400	0,157	3,923	R1 980,00
		Control	1440	14,4	22,594	0,024	0,173	0,198	0,877	285,302	1000	0,285	2,853	R3 600,00
Thoko	Zuma	Trial	480	4,8	22,594	0,024	0,173	0,198	0,877	95,101	400	0,095	2,378	R1 200,00
		Control	300	3	22,594	0,024	0,173	0,198	0,877	59,438	600	0,059	0,991	R750,00

	Nathaniel	Myeza	Trial	180	1,8	22,594	0,024	0,173	0,198	0,877	35,663	400	0,036	0,892	R450,00
			Control	0	0	0,000	0,024	0,000	0,024	0,000	0,000	400	0,000	0,000	R0,00
	Nokuthula	Dube	Trial	108	1,08	28,105	0,024	0,173	0,198	0,877	26,617	400	0,027	0,665	R150,00
			Control	0	0	22,594	0,024	0,000	0,000	0,000	0,000	0	0,000	0,000	R0,00
	MaZondi	Xulu	Trial	360	3,6	22,594	0,024	0,173	0,198	0,877	71,325	300	0,071	2,378	R1 200,00
			Control	600	6	22,594	0,024	0,173	0,198	0,877	118,876	400	0,119	2,972	R1 500,00
	Total (Trial):													**13,624**	**R7 320,000**
	Total (Control):													**7,410**	**R7 650,000**
Ozwa-Swedi Trial	**Average Yield Trial**													**1,946**	**R1 220,000**
Ozwa-Swedi Cont	**Average Yield Control**													**1,059**	**1275,000**
	Name	**Surname**	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**%grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**	**Income**
	Thuthukani	Mthembu	Trial	396	3,96	17,082	0,084	0,173	0,258	0,673	45,506	400	0,046	1,138	R1 320,00
	Ntombencane	Gasa	Trial	0	0	0,000	0,000	0,000	0,000	0,000	67,335	300	0,067	2,245	
	Thanda	Mathonsi	Trial	0	0	0,000	0,000	0,000	0,000	0,000	68,050	200	0,068	3,403	
	Delisile	Ngobeni	Trial	0	0	0,000	0,000	0,000	0,000	0,000	66,600	400	0,067	1,665	R385,00
	smephi	choncho	Trial	0	0	0,000	0,000	0,000	0,000	0,000	52,870	200	0,053	2,644	
	Rita	Ngobese	Trial	300	3	23,010	0,030	0,208	0,239	0,874	60,299	400	0,023	0,575	R105,00
			Control		3	10,338	0,030	0,208	0,239	0,874	27,092	400	0,010	0,258	
	Khombisile	Mncanyane	Trial	500	5	15,530	0,084	0,173	0,258	0,673	52,235	400	0,052	1,306	R1 200,00
			Control	0	0	0,000	0,000	0,000	0,000	0,000	0,000	400	0,000	0,000	
	Nelisiwe	Ngcobo	Trial	0	0	0	0	0	0	0	40,000	400	0,040	1,000	
	Flomina	Mbatha	Trial	532	5	15,530	0,084	0,173	0,258	0,673	52,235	200	0,052	2,612	
	Thokozile	Mahlaba	Trial	660	6,6	15,530	0,084	0,173	0,258	0,673	68,951	200	0,069	3,448	
	Miriam	Ngubane	Trial	84	1	15,530	0,084	0,173	0,258	0,673	10,447	200	0,010	0,522	

	Total (Trial):													**20,814**	
	Total (Control):													**20,556**	
Gobizembe Trial	**Averge Yield Trial**													**1,180**	**R3 010,00**
	Average Yield Control													**2,937**	
	Name	**Surname**	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**%grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**	
	Fikile	Ntshingila	Trial	600	6	12,083	0,037	0,182	0,218	0,832	60,324	200	0,060	3,016	
	Ntombi	Duma	Trial	0	0	17,082	0,000	0,000	0,000	0,000	121,918	400	0,122	3,048	
	Thembi	Xaba	Trial	1000	10	17,082	0,116	0,173	0,289	0,599	102,360	400	0,102	2,559	
	Gabsile	Sithole	Trial	150	1,5	17,082	0,116	0,173	0,289	0,599	40,000	400	0,040	1,000	
	Mrs	Xulu	Trial	0	0	0,000	0,000	0,000	0,000	0,000	74,315	400	0,074	1,858	
	Sibongile	Zuma	Trial	300	3	17,082	0,116	0,173	0,289	0,599	30,708	300	0,031	1,024	
	Happy	Ntshangase	Trial	0	0	0	0	0	0	0	120,000	400	0,120	3,000	
	Thabile	Molo	Trial								50,000	400	0,050	1,250	
	Mama	Sibisi	Trial	150	3	17,082	0,116	0,173	0,289	0,599	50,000	400	0,050	1,250	
	Thobile	Mbanjwa	Trial	0	0	0	0	0	0	0	151,350	400	0,151	3,784	
	Total (Trial):													**10,433**	
Ntabamhlophe	**Average Yield Trial**													**1,490**	
		Surname	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**%grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**	
	Mbhekeni	Mazibuko	Trial	96	3	13,665	0,116	0,173	0,289	0,599	24,565	200	0,025	1,228	
	Khumbuzile	Nqubuka	Trial	0	0	0,000	0,000	0,000	0,000	0,000	121,918	400	0,122	3,048	
	Naphthali	Mngadi	Trial	1000	10	17,082	0,116	0,173	0,289	0,599	102,360	400	0,102	2,559	

Michael	Nene	Trial	150	1,5	17,082	0,116	0,173	0,289	0,599	40,000	400	0,040	1,000
Victoria	Gumbi	Trial	0	0	0,000	0,000	0,000	0,000	0,000	74,315	400	0,074	1,858
Ntokozo	Khanyi	Trial	300	3	17,082	0,116	0,173	0,289	0,599	30,708	300	0,031	1,024
Thandiwe	Khanyi	Trial	0	0	0	0	0	0	0	120,000	400	0,120	3,000
Lindiwe	Ntshalintshali	Trial								50,000	400	0,050	1,250
Tholakele	Mdakane	Trial	150	3	17,082	0,116	0,173	0,289	0,599	50,000	400	0,050	1,250
Ntombi	Mncube	Trial	0	0	0	0	0	0	0	151,350	400	0,151	3,784
Total (Trial):													**20,000**
Average Yield Trial													**2,000**

Loskop

Name	**Surname**	**Treatment**	**No of Cobs**	**No of Bags**	**Av. weight (kg)/bag**	**Av. Weight of cob**	**Av. weight of grain**	**weight of cob + grain**	**%grain weight**	**Grain weight (kg)**	**area (m2)**	**Weight (t)**	**weight (t/ha)**
Thuthukani	Mthembu	Trial	396	3,96	17,082	0,084	0,173	0,258	0,673	45,506	400	0,046	1,138
Ntombencane	Gasa	Trial	0	0	0,000	0,000	0,000	0,000	0,000	67,335	300	0,067	2,245
Thanda	Mathonsi	Trial	0	0	0,000	0,000	0,000	0,000	0,000	68,050	200	0,068	3,403
Delisile	Ngobeni	Trial	0	0	0,000	0,000	0,000	0,000	0,000	66,600	400	0,067	1,665
smephi	choncho	Trial	0	0	0,000	0,000	0,000	0,000	0,000	52,870	200	0,053	2,644
Rita	Ngobese	Trial	300	3	23,010	0,030	0,208	0,239	0,874	60,299	400	0,023	0,575
		Control		3	10,338	0,030	0,208	0,239	0,874	27,092	400	0,010	0,258
Khombisile	Mncanyane	Trial	500	5	15,530	0,084	0,173	0,258	0,673	52,235	400	0,052	1,306
		Control	0	0	0,000	0,000	0,000	0,000	0,000	0,000	400	0,000	0,000
Nelisiwe	Ngcobo	Trial	0	0	0	0	0	0	0	40,000	400	0,040	1,000
Flomina	Mbatha	Trial	532	5	15,530	0,084	0,173	0,258	0,673	52,235	200	0,052	2,612
Thokozile	Mahlaba	Trial	660	6,6	15,530	0,084	0,173	0,258	0,673	68,951	200	0,069	3,448
Miriam	Ngubane	Trial	84	1	15,530	0,084	0,173	0,258	0,673	10,447	200	0,010	0,522
Total (Trial):													**20,814**

	Name	Surname	Treatment	No of Cobs	No of Bags	Av. weight (kg)/bag	Av. Weight of cob	Av. weight of grain	weight of cob + grain	%grain weight	Grain weight (kg)	area (m2)	Weight (t)	weight (t/ha)
	Total (Control):													**4,485**
Gobizembe	**Averge Yield Trial**													**3,074**
	Gabi	Ngcobo	Trial	200	2	13,865	0,017	0,173	0,190	0,910	25,240	200	0,025	1,262
	Moses	Chonco	Trial	0	1	12,320	0,017	0,173	0,190	0,910	11,214	400	0,011	0,280
	Gwaja	Khumalo	Trial	100	1	25,000	0,017	0,173	0,190	0,910	22,755	100	0,023	2,276
	Petros	Khumalo	Trial	0						0,000	98,880	300	0,099	3,296
	Jabulile	Mdletshe	Trial	200	2	13,865	0,017	0,173	0,190	0,910	25,240	250	0,025	1,010
	Total (Trial):													**8,123**
Cornfields	**Average Yield Trial**													**1,625**