# The critical role of crop diversity in conservation agriculture in the North West

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Before this article gets into the details of crop diversification in conservation agriculture (CA) in the North West, it is good to first return to the principles of conservation agriculture that promote soil health and sustainability, especially with the potential role of cover crops in mind:

- Cover soil with plant material to protect it.
- Use no-till implements as this will cause very little disturbance of the soil.
- Use all functional groups of plants to increase the diversity of fields.
- Provide nutrition and protection throughout the year with live roots and cover to stimulate microbes in the soil profile.
- Use cover crops in a crop rotation system with cash crops to integrate livestock on fields. However, utilisation should meet specific requirements, such as high-pressure grazing and short grazing periods.

A screening trial – first implemented during the 2013/14 planting season and consisting of various cover crops – was established in the Ottosdal area. Trials were planted on George Steyn's farm Humanskraal – he is also an active member of the Ottosdal No-till Club. The layout of the trial included summer annuals, winter annuals, cash crops and mixtures.

## At least three crops

A complete randomised block design was used for this experiment and consisted of 17 treatments, crops or mixtures. The width of each treatment strip is equal to two planter widths. During the following season the crops are planted across the previous season's planting strips to evaluate the rotation effect each crop has on the other. Hence, each crop is planted as a monoculture and rotated with all other crops. CA requires the use of at least three crops in a rotation system. The practical value or outcome of this trial is to confidently integrate cover crops in a mixed CA system in the North West province.

The purpose of the trial is as follows:

- To investigate the ability of different crops to adapt to local environmental conditions for possible application in a CA system.
- To give producers the opportunity to familiarise themselves with crops and to observe and gain first-hand experience regarding the potential beneficial effect on soil health.
- To collect data on the ability of the crops to establish ground cover, evaluate information on potential pests, measure the effect of crops on soil health, measure the impact of crops on soil water and correlate its possible effect on follow-up plantings, investigate the rotation effect of crops on each other, and look at possible N mineralisation/immobilisation.

*The layout of the trial.*

As a whole, the 2013/14 season was a particularly good rain season and most crops performed well. The following lessons were learned during this season:

- Babala was planted too deep and emergence was poor. Large seeds such as velvet bean (*Mucuna pruriens*) cause problems and cannot be planted with normal planter plates.
- Residual herbicides (atrazine) lead to poor emergence of sunflower, velvet beans and lablab, but cowpeas do not show any damage.
- Bagrada bugs on radishes are a problem.
- Gerbils are a serious problem if cover crops are not grazed, especially in sunflower.
- Weed control is important and cover crops should be planted in a clean seedbed.
- Mixtures generally do well and can possibly save time biologically.
- Small grains such as rye, triticale and black oats should preferably be rolled at a soft dough stage or sprayed with a chemical herbicide to stop growth. Volunteering becomes a problem if Round-up Ready maize is not planted.

*Trial sites in Ottosdal during the drought of the 2014/15 season. This photograph taken on 16 February 2015 clearly indicates the effect of the drought. Some sites showed withering during pollination.*

The 2014/15 planting season was very dry with effective rainfall of approximately 350mm. Late maize plantings performed better than early maize plantings. Gerbils, particularly following legumes, caused a lot of damage in especially sunflower plantings. On sites with large amounts of residues, e.g. grain sorghum, relatively little damage was observed.

## Good rain season

*Figure 1* illustrates the residues on the soil surface after a particularly good rain season. Sunflower and soya residues decay quickly and will not meet the 30% cover required for CA. The crop residue cover of rye is also less than 30%, but this may be due to weak emergence. Rye usually produces residues with a high C:N ratio that is hard to break down.

*Figure 2* shows the average crop yields during the 2014/15 season. If the total biomass yield of maize is taken as an example and compared to the yields of the previous planting season, it is approximately 80% lower. However, the summer crops babala and forage sorghum are in good condition, as well as the summer legumes such as velvet beans, cowpeas and lablab, which are all doing very well in low rainfall conditions. Among the winter crops, especially oats and triticale perform well amid all treatments.

During the 2015/16 planting season, very little rain fell in December 2015 and the screening test was only established in mid-January. The so-called 'regenerative trial', which includes a summer mixture, was only established at the end of January and a winter cover crop mixture in the first week of February.

**Figure 2: Average dry material (DM) yield of crops in the 2014/15 season.**

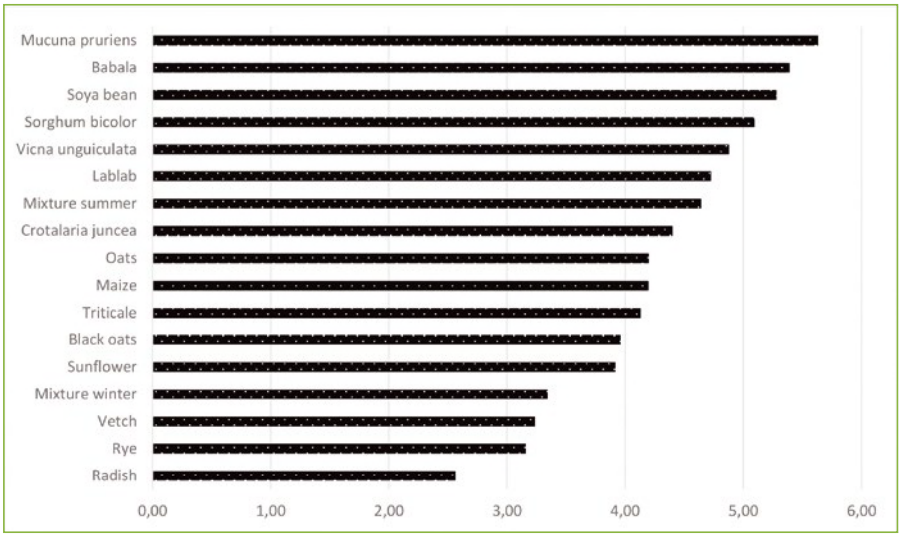
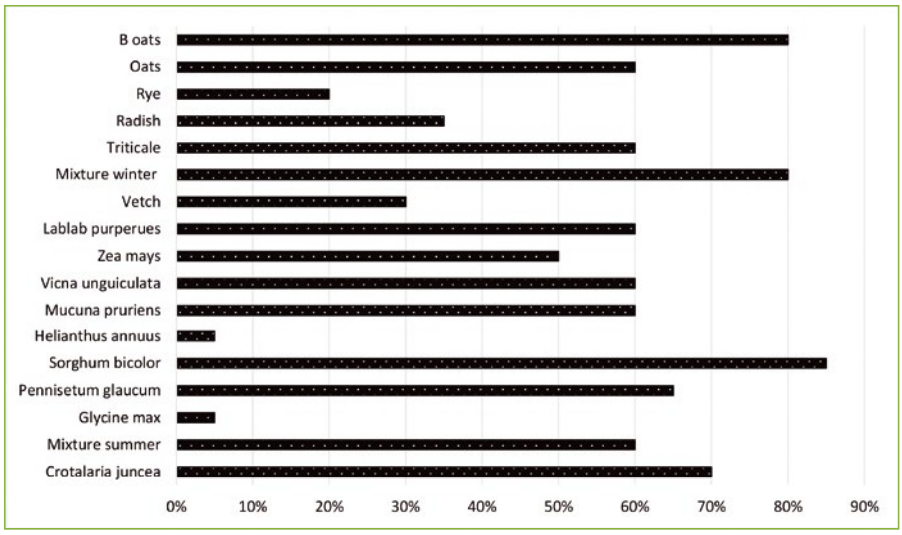


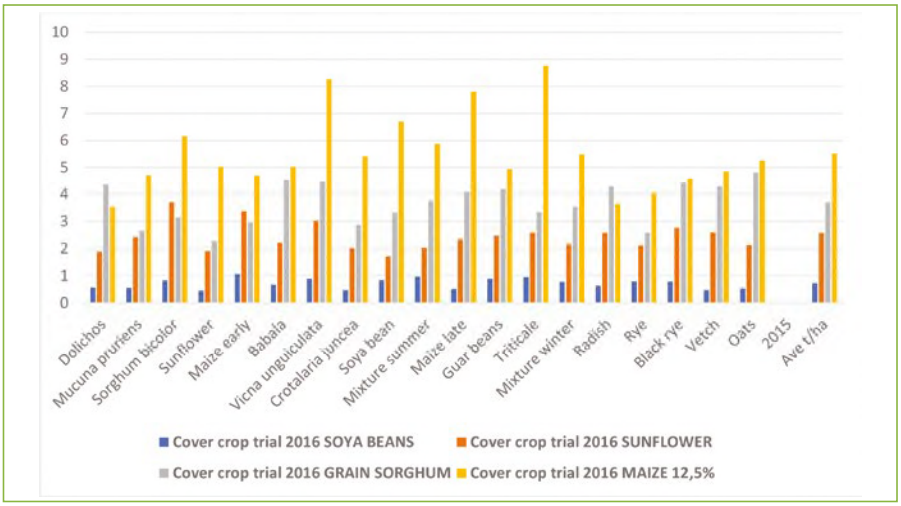

**Figure 1: Percentage ground cover of different crop residues.**




An overall effective rainfall figure of 370mm was recorded for the year. The distribution of rain after planting improved and good showers occurred before and until May. Biological soil analyses show that the low soil moisture and high temperatures can affect soil microbe activity, as these measurements decreased drastically. However, the yield of cash crops on the same fields show the opposite, as indicated in *Figure 3*.

Soya bean, sunflower, grain sorghum and maize fetched an average yield of 0,721, 2,57, 3,68 and 5,52t/ha respectively, across all treatments.

**Figure 3: Grain yield of different crops over different seasons.**




Considering the dry weather conditions, there results are remarkable, and the following conclusions can be made:

- Soya beans perform well on treatments in rotation with maize, a summer mixture and triticale.
- Sunflower performs well on treatments in rotation with grain sorghum, maize and cowpeas.
- Grain sorghum performs well on treatments in rotation with oats, cowpeas and babala.
- Maize performs well on treatments in rotation with triticale, cowpeas and maize.

## Regenerative trial

The trial site used to plant regenerative summer and winter cover crop mixtures, was previously used to cultivate cash crops. However, the field was badly damaged by soil erosion. The soil type is of the Tukulu soil form and the soil depth is approximately 600mm. The field or site was withdrawn due to poor production; it was decided to use a disc plough to cultivate it before the trial was established.

George Steyn initially planned to plant perennial grass, which would probably have yielded good results. Annual summer and winter cover crop mixtures were proposed as a possible way to recover or rehabilitate the soil for production. Only the summer mixture is described in this article, although the winter mixture was also successful with a production of around 11t/ha DM.

It is known that a large amount of organic matter (at least 6t/ha DM) is needed to prevent run-off in cultivated fields. It has also been determined that between 50-70% moisture evaporated from the bare soil, which negatively affected the use efficiency of rainfall – efficiency is especially important in the drier western regions.

The main purpose of the trails was to produce and retain as many crop residues as possible to improve the soil. For this reason, the cover crops were not rolled as contact with the soil would have increased the breaking down of plant residues. *Photos 3* to *6* illustrate the process.

*Photo 3* was taken on 27 January 2016, before the planting of a mixture of ten summer species that included all cash crops and all three legumes, two annual summer grasses, and one of the radish species.

*Photo 3: Bare soil before planting.*

*Photo 4: A good summer cover crop mixture stand.*

*Photo 4* was taken in mid-April 2016. DM was determined and ranged between 11-14t/ha.

*Photo 5* was taken at the beginning of September. The sunflower was harvested and produced a yield of 2,2 tons from the 14ha. The mixture can also be used as grazing and is very profitable. The monetary value of the 2,2 tons of sunflower covered all the planting costs. The photo clearly shows that most of the crop residues were retained.

*Photo 5: Crop residues at the end of the growth season.*

*Photo 6: Maize planted in between crop residues, January 2017.*

*Photo 6* was taken in mid-January 2017 after maize was planted in between the crop residues. The rate at which the soil biota processed the crop residues is emphasised and only babala stems remained.

## Conclusion

In an international meta-analysis done with 48 crops in 63 countries, it was found that if no-till is implemented without a cover and crop rotation, crop losses of -9,9% can be realised compared to the conventional process.

No-till with only cover or only crop rotation caused losses of -5,2% and -6,2%, respectively. However, if no-till is applied with cover and crop diversification under dryland conditions in semi-arid areas, a yield increase of 7,2% is achieved.

Therefore, we conclude that more farmers will possibly use CA to manage the negative impact of climate change. Instead of regarding no-till as the first step, the other two elements – retention of a cover and crop diversity – should first be in place. This will lead to a more acceptable result. In this process cover crops can play an important role.

**Source:** Pittelkow, CM *et al.*, 2014. *Productivity limits and potentials of the principles of conservation agriculture.*