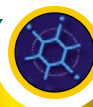


# OILSEEDS

# focus

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Soya bean inoculation



Peanuts and heart health

Chemical manipulation of canola

Ammonium sulphate in weed control



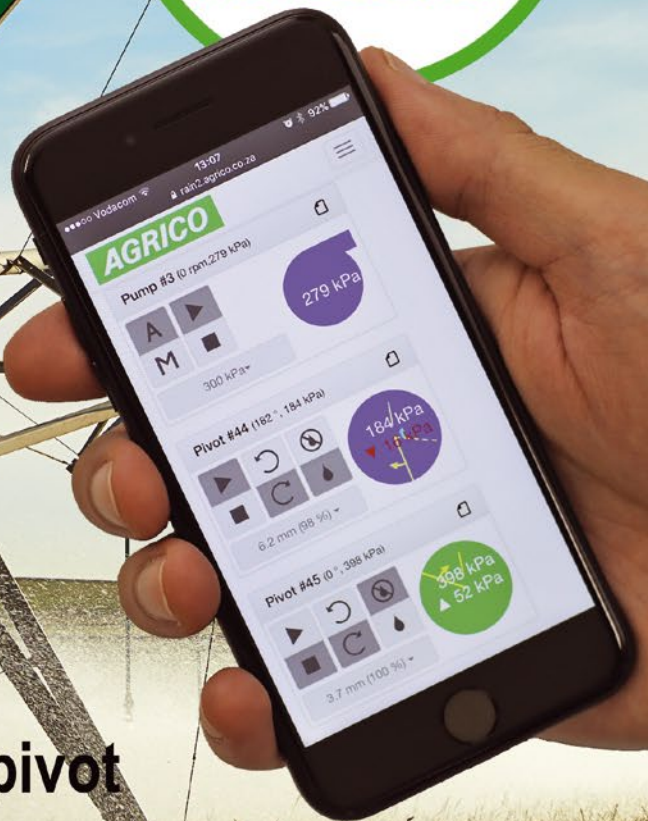
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# Food security and malnutrition

By Wilna Oldewage-Theron, PhD RD(SA), Texas Tech University, Lubbock, Texas

**F**ood security is defined by the United Nations' Food and Agriculture Organization (FAO) as follows: "Food and nutrition security exists when all people at all times have physical, social and economic access to food of sufficient quantity and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life, coupled with a sanitary environment, adequate health, education and care."

The opposite, namely food insecurity, has been around since biblical times and can be traced to when Joseph predicted seven years of plenty and seven years of famine. The plans he made are the first example of food security planning.

## The burden of food insecurity

During the food crisis of the 1970s, it became clear that food security was a common concern for many countries and was then added to the development debate. The Millennium Development Goals (MDGs) and subsequent Sustainable Development Goals (SDGs) of the United Nations were global strategies implemented to promote prosperity while protecting the planet.

Despite many international initiatives to address food insecurity, The State of Food Security and Nutrition in the World 2018 report showed that world hunger has increased in recent years to that of almost a decade ago – from 804 million in 2016 to almost 821 million in 2017, thus one out of every nine people.

Regardless of vast improvements in South Africa, 22,3% of the population still has insufficient food for an active and healthy life and 11,8% experience chronic hunger. Recent land reform disputes might further aggravate the situation. Food insecurity is not only associated

with malnutrition, but also with overweight and obesity. The world is now facing a double burden of malnutrition, with insufficient energy (calories) and nutrient intake on the one hand and excess energy intake on the other.

Undernourishment is characterised by protein-energy malnutrition (stunting, wasting and underweight) mainly in children, as well as micronutrient deficiencies (e.g. vitamin A, D, B6, B12, zinc and iron) affecting people throughout their lifespan. Malnutrition has major consequences for rapidly growing infants and young children, such as poor physical and mental development.

On the other hand, South Africa has a high prevalence of overweight and obesity in adults; however, this is not only an adult problem as 25% of girls and 20% of boys, aged two to 14 years old, are overweight or obese. Obesity is often associated with diet-related non-communicable diseases (NCDs), such as heart disease, type 2 diabetes, cancer and blood pressure.

## The solution

It is clear that hunger and food insecurity and its associated malnutrition is a persistent problem. Adequate nutrition is key for the prevention of hunger and malnutrition. Yet the challenges are numerous – more food is needed for the growing population, but food and agricultural systems are vulnerable to many risks, such as climate change, emerging water scarcities, and market volatility, to name a few.

Agricultural development has been recognised as a sustainable approach to address food insecurity. Collaborative efforts between the government, academia, producers and processors



Wilna Oldewage-Theron (Photograph: Texas Tech University).

should thus be strengthened to increase productivity while conserving the natural resources, as well as improve access to affordable nutritious food to address not only food insecurity but also malnutrition.

Legumes and soya beans have been identified as economical and versatile foods that will not only provide essential nutrients for malnutrition, but also add additional and unique health benefits that will address the increasing prevalence of over-nutrition. Legume and soya bean production should be promoted as it not only has health benefits, but also offers many processing opportunities for value addition in terms of cheap protein sources. 🌱

For more information, email the author at [wilna.oldewage@ttu.edu](mailto:wilna.oldewage@ttu.edu).

# The nutrient content of oilseeds

The economic realities of oilseed production have placed the emphasis on maximum yield to sustain economic viability. However, downstream customers are mainly purchasing nutrients such as oil, protein and amino acids rather than volume.

The environmental conditions under which oilseeds are produced, such as temperature, rainfall, latitude and daylight length, have the biggest influence on nutrient content, while the influence of the producer is more challenging, although it can be a contributing factor. Improved fertilisation, disease management and numerous other practices can further contribute to production.

South Africa's real dilemma is that environmental challenges have resulted in an often lower nutrient content – which is the key economic driver for oilseed end users – in locally produced oilseeds compared to that of our global competitors. The industry needs to investigate ways to create a win-win situation along the oilseed value chain with regard to higher nutrient content.

## Uses of soya beans

We are confident that a system will be put in place in future where producers will be compensated for their supply of nutrients, rather than the quantity of a basic material. This challenge will benefit both producers and consumers, and must be pursued aggressively.

When a producer sells soya beans to the market, the beans could be used in several ways. As soya beans consist of approximately 18 and 38% protein, the high protein content makes it an ideal ingredient for animal feed. Smaller quantities are processed into products such as soya milk, soya flour, soya protein, tofu and many retail products for human consumption.

Soya products can also be used in many non-food (industrial) items. The nutrient contribution of soya beans in human nutrition as an affordable source of protein, has never been in doubt. However, to convert these nutrients into a mainstream staple food product acceptable to consumers, remains a challenge in South Africa.

## Major momentum

Progress in technology has resulted in seed companies having the ability to improve the quality and characteristics of soya beans on an ongoing basis. The emphasis has been on yield, but many other improved attributes, such as nematode resistance, herbicide tolerance and several other characteristics, have improved the product.

The self-imposed adoption of a technology levy in South Africa, which will be funded by producers, will speed up the drive to not only attract the latest technology to the country, but also to increase the need to identify the best performing cultivar for South Africa as well as the right cultivar for each environment.

I am convinced that if the industry faces this challenge head on, it will add much needed momentum to our advancement.

Dr Erhard Briedenhann

Send us your contributions and suggestions to make *Oilseeds Focus* an enjoyable and valuable publication for the oilseeds industry. Contact Dr Briedenhann at [erhardb@netactive.co.za](mailto:erhardb@netactive.co.za) for more information.

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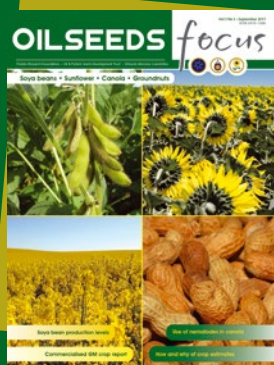


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## Soya bean trade war wages on

Usually farmers in the United States (US) would have sold tons of soya beans by now, but not this year. The main export market, namely China, has all but stopped buying. The Chinese government imposed a tariff on American soya beans in response to the Trump administration's tariffs on Chinese goods. The latest federal data, through mid-October, shows that American soya bean sales to China have declined by 94% from last year's harvest. The hope is that prices will rise before the beans rot.

President Trump sees tariffs as a tool to force changes in America's economic relationships with China and other major trading partners. His tough approach, he says, will revive American industries such as steel and auto manufacturing that have lost ground to foreign rivals. But that is coming at a steep cost for some industries, such as farming, that have thrived in the era of globalisation by exporting goods to foreign markets. The United States exported \$26 billion in soya beans last year, and more than half went to China.

China is by far the world's largest importer of soya beans. The country consumed 110 million tons of soya beans in 2017, and 87% of those beans were imported — the vast majority from either Brazil or the United States. Soya bean farmers also spent millions of dollars cultivating the Chinese market. As China swallows the world's supply of non-American soya beans, other countries are buying more beans from the United States, especially European nations that usually import beans from Brazil. – [www.nytimes.com](http://www.nytimes.com)

## Feed ingredients remain a challenge

Organic food sales in the US increased by 6,3% year-on-year in 2017, with the value of organic sales climbing from \$3,4 billion in 1997 to more than \$45 billion last year. Behind this growth remains the challenge of sourcing adequate organic feed ingredients to support the necessary food production to meet demand.

Yorktown Organics, a poultry feed producer in Illinois, started their business when organic producers in the region were sourcing organic feed from more than 320km away. Since then the company has become a key player in supporting the organic egg industry, supplying feed to produce more than 10% of the organic eggs on US shelves.

Until 2017, the US produced only 75% of the organic maize needed to feed organic poultry in the country, and only 10% of the necessary organic soya beans – with the balance being imported. This supply gap reflects a need for an additional 162 000ha of organic soya beans to be grown and harvested in the US. – [www.feednavigator.com](http://www.feednavigator.com)

## Processing agreement secured

Minnesota-based biotech company Calyxt announced it has secured an agreement with American Natural Processors (ANP) to crush Calyxt's gene-edited high-oleic soya bean variety to produce the company's high oleic soya bean oil.

Calyxt is a company with a mission to use technology to develop crop traits that produce healthier food ingredients. Through its work, Calyxt aims to create varieties of soya beans, wheat, canola, lucerne, and potatoes with the ability to improve consumer health, reduce pesticide usage, increase crop disease tolerance, and mitigate the environmental impact of production.

"We consider ourselves to be stewards of the land, producing food that are not only nutritionally rich and cost-effective but also sustainable and environmentally friendly," says Manoj Sahoo, chief commercial officer of Calyxt. "After receiving strong interest from farmers and food companies for our first product candidate, we are excited to work with a crusher that shares our objective of impeccable product quality for consumers."

Calyxt's high-oleic soya bean variety has been developed using a genome engineering technique called TALEN® – a best-in-class genome engineering platform that enables the binding and cleaving of pre-selected sequences of DNA. Using TALEN®, which can work like 'molecular scissors', Calyxt's technology does not introduce foreign DNA into the selected crop variety, leading the US Department of Agriculture (USDA) to confirm in 2015 that the company's high-oleic soya beans are non-GMO and non-regulated. – [www.oilseedandgrain.com](http://www.oilseedandgrain.com)





### Celebrate World Soil Day in December

World Soil Day (WSD) is held annually on 5 December as a means to focus attention on the importance of healthy soil and advocating for the sustainable management of soil resources.

An international day to celebrate soil was recommended by the International Union of Soil Sciences (IUSS) in 2002. Under the leadership of the Kingdom of Thailand and within the framework of the Global Soil Partnership, the FAO has supported the formal establishment of WSD as a global awareness-raising platform.

The FAO conference unanimously endorsed World Soil Day in June 2013 and requested its official adoption at the 68th UN General Assembly. In December 2013, the UN General Assembly responded by designating 5 December 2014 as the first official World Soil Day.

This date, 5 December, was chosen because it corresponds with the official birthday of HM King Bhumibol Adulyadej, the king of Thailand, who officially sanctioned the event. In 2016, this day was officially recognised in memory of and with respect for this beloved monarch who passed away in October 2016 after seven decades as head of state.

#StopSoilPollution is at the heart of the Global Soil Partnership's mandate as demonstrated by the Global Symposium on Soil Pollution. We work to ensure that people have safe and nutritious food to ensure an active and healthy life without endangering essential ecosystems. It is time to #StopSoilPollution, join forces, and turn determination into action. – FAO

### Sunflower season delayed

The optimal planting window that opened at the beginning of November in the sunflower seed growing areas, was quiet. Fields remained unplanted since expected rainfall had not yet materialised in most areas. However, the optimal planting window for sunflower remains open until early January 2019, according to a market update by Wandile Sihlobo, head of economic and agribusiness intelligence at Agbiz.

Agbiz maintained their view that it would be ideal if farmers in areas with better soil moisture could start planting as soon as possible, so that the pollination period occurs early next year when the chance for higher rainfall is still good.

If the planting activity starts late, the pollination process of the crop could coincide with the expected drier weather conditions between the end of January 2019 and March 2019. This could result in poor yields in some areas, depending on the soil moisture levels.

Apart from the weather developments, there was a bit of despondency in the sunflower seed market, as the recent data from the Crop Estimates Committee suggested that the 2018/19 sunflower seed planting could decline by 4% from the previous season to 575 000ha, which is slightly below the long-term average area of 576 490ha.

It is worth highlighting, though, that these are intentions and not actual plantings. A much clearer view will emerge when the committee releases its preliminary area estimate on 29 January 2019. – AgriOrbit

### Canola farmers crowned Farmer of the Year

Two brothers, Johan and Dirkie van As from Swellendam in the Western Cape, were named the 2018 Grain SA/Syngenta Grain Producer of the Year at the Grain SA annual gala awards evening, held at The Theatre on the Track in Midrand on Friday, 12 October 2018.

Honouring the country's top grain producers, this year's awards ceremony commemorated the 19th year of the accolades and was attended by the deputy minister for agriculture, forestry and fisheries, Sifiso Buthelezi, together with senior governmental officials, representatives of the various agricultural trusts, organised agriculture as well as captains of industry and the grain producing guests of honour.

Johan and Dirkie have been involved in the family farm,

Kinko, since 1985. Both brothers have approach farming as perfectionists, with Johan mainly seeing to the finances and livestock, and Dirkie taking charge of the grain production.

Even so, the different legs of this successful farming operation are transparent and all future planning and purchasing decisions are discussed and decided upon as a team. The Van As brothers cultivate canola, barley, wheat and lucerne on approximately 8 700ha.

Their livestock consists of stud and commercial sheep, with around 11 000 breeding ewes and approximately 10 000 sheep for a wool-meat production system. The brothers believe that agriculture is the cornerstone of the South African economy and that a strong agricultural sector driven by stability, sustainability and food security are the key to success. – Press release 🌱





# Manipulating vegetative growth and reproductive development in canola

By Prof André Agenbag, Protein Research Foundation

**E**xpansion of canola (*Brassica napus* L.) as a crop in South Africa is still hampered by generally low grain yields, with resultant profit margins that are less than that obtained with grain crops such as wheat and barley.

Lower than expected yields may be the result of several factors, such as low and uneven plant populations when compared to Canadian crops, insect pests, poor plant nutrition management and weed control, as well as harvesting losses.

The highest yields are achieved with early plantings on high fertility sites, although this practice can produce bulky crops that, in combination with high plant populations, may result in lodging during pod development. Similar to Australia where canola is grown as a winter crop, plants in South Africa grow much taller compared to Canada and lodging may become a serious problem if canola is planted early at high planting densities.

Although bulky crops may show high yield potential at flowering, this potential often does not materialise due to poor light penetration and inefficiency in assimilate remobilisation, which result in fewer seeds per pod and a greater portion of immature pods (Armstrong and Nicol, 1991).

## Plant growth regulators

Research done in Australia with plant growth regulators (PGRs) (Armstrong and Nicol, 1991) showed that:

- PGRs can reduce plant height.
- Shorter canola plants are less prone to lodging.
- PGRs can change the canopy structure of canola to produce a more compact, evenly developed plant canopy, which improves the penetration of sunlight and reduces competition for assimilates.
- Evenly developing plants will have more uniform ripening, which will reduce pod shattering and harvesting losses.

No PGRs are at present registered for use in canola in South Africa, but preliminary studies showed that PGRs with trinexapac-ethyl as active ingredient (Primo Maxx® and Moddus®) as well as liquid seaweed extract (Kelpak®) showed promising results in both pot and field trials.

Although Kelpak® is not a PGR in the sense that plant growth (height) is reduced, it may help to reduce lodging and increase canola yields due to improved rooting systems and an increase in stem diameter (Ferreira and Lourens, 2002); the product is registered for use in canola in South Africa. Both products are used in grain crops, though optimum application rates and time of application for canola are not yet determined.

## Trials with Kelpak® and Moddus®

Field trials were conducted during the 2015-2017 growth seasons at high rainfall (Altona: 645mm annually) and medium rainfall (Langgewens: 473mm annually) localities in the Swartland and



a high rainfall (Roodebloem: 563mm annually) locality in the Southern Cape.

Five spraying treatments – an unsprayed control compared to Kelpak® (liquid seaweed extract) at 2 and 4ℓ/ha and Moddus® (trinexapac-ethyl) at 0,4 and 0,8ℓ/ha – were tested with the spraying treatments done at budding stage (start of stem elongation) or at budding and start of flowering. These spraying treatments were also tested in a low density (30-40 plants/m<sup>2</sup>) and a high density (> 70 plants/m<sup>2</sup>) crop with spraying done at budding stage.

Large differences in climatic (rainfall) conditions were experienced during the experimental period (2015-2017). In the Swartland, very dry conditions (the driest since 1978) prevailed during the period with growth season (April to September) rainfall of only 193mm (2015) and 194mm (2017), compared to a long-term average of 334mm measured at the Langgewens locality.

During 2016, the growth season rainfall in the Swartland was almost the same as the long-term average at Langgewens and cool and above average rainfall in September ensured high yielding crops. Although above average rainfall conditions were experienced in the Southern Cape (Roodebloem locality) during 2015, crop yields were hampered due to a very dry planting season (April to May) followed by very cold and wet conditions in June.

**Table 2: Number of flowering stems per plant of canola during 2015 at different localities in response to chemical treatments on low- and high-density crops.**

|                    |          | Altona | Langgewens | Roodebloem |
|--------------------|----------|--------|------------|------------|
| Low plant density  | Control  | 2,59cd | 3,30cd     | 4,25c      |
|                    | Kelpak 1 | 3,13a  | 3,63bc     | 5,65ab     |
|                    | Kelpak 2 | 2,68cd | 3,54bcd    | 5,30b      |
|                    | Moddus 1 | 2,83bc | 3,60bc     | 6,35a      |
|                    | Moddus 2 | 2,83bc | 3,82ab     | 5,98ab     |
| High plant density | Control  | 2,10e  | 3,20d      | 3,63cd     |
|                    | Kelpak 1 | 2,48d  | 4,03a      | 3,25d      |
|                    | Kelpak 2 | 3,08ab | 3,81ab     | 3,75cd     |
|                    | Moddus 1 | 2,60cd | 3,42cd     | 4,10cd     |
|                    | Moddus 2 | 2,60cd | 3,45bcd    | 4,00cd     |

Kelpak 1 = 2ℓ/ha; Kelpak 2 = 4ℓ/ha; Moddus 1 = 0,4ℓ/ha; Moddus 2 = 0,8ℓ/ha

Means in the same row for each treatment with at least a common letter are not significantly different, LSD<sub>0,05</sub>

**Table 1: Plant heights (cm) of canola in 2015 at different localities in response to chemical treatments at budding (start of stem elongation) compared to treatments at budding and start of flowering.**

|                              |          | Altona | Langgewens | Roodebloem |
|------------------------------|----------|--------|------------|------------|
| Spray at budding             | Control  | 127,1a | 104,5a     | 98,0ab     |
|                              | Kelpak 1 | 126,4a | 104,8a     | 99,1ab     |
|                              | Kelpak 2 | 126,8a | 105,7a     | 100,2a     |
|                              | Moddus 1 | 123,1a | 103,1a     | 96,4ab     |
|                              | Moddus 2 | 122,0a | 102,7a     | 95,2b      |
| Spray at budding + flowering | Control  | 128,2a | 105,4a     | 100,0a     |
|                              | Kelpak 1 | 127,4a | 106,6a     | 102,0a     |
|                              | Kelpak 2 | 128,5a | 105,7a     | 103,4a     |
|                              | Moddus 1 | 122,1a | 101,4a     | 94,0b      |
|                              | Moddus 2 | 121,0a | 100,5a     | 94,6b      |

Kelpak 1 = 2ℓ/ha; Kelpak 2 = 4ℓ/ha; Moddus 1 = 0,4ℓ/ha; Moddus 2 = 0,8ℓ/ha

Means in the same row for each treatment with at least a common letter are not significantly different, LSD<sub>0,05</sub>

Total growth season rainfall in the Southern Cape during 2016 was also close to the long-term average, but the rainy season started late, which shortened the growth season and reduced yield potential. Although growth season rainfall in 2017 was nearly 20% less than the long-term average at the Roodebloem locality, the rainfall was well distributed to ensure high yielding crops.

### Plant heights

As expected, the plant growth inhibitor Moddus® reduced plant heights in 2015,

but differences were not consistent and varied between localities. In contrast, Kelpak® treatments had no or very little effect on plant height (Table 1). Application rates (recommended or double), time of application (budding or budding plus flowering), and plant density did not have an effect on the response to chemical treatments at any locality in 2015. No treatment effects were shown in 2016 or 2017.

### Number of flowering stems

Due to the generally poor growing conditions in 2015, the number of flowering stems at especially Altona and Langgewens were low and varied between two and five stems per plant. Application time of chemical treatments had no effect on the number of flowering stems per plant at Langgewens, but at Altona and Roodebloem treatments with especially Moddus® resulted in a higher number of flowering stems produced.

Although significant increases in the number of flowering stems per plant due to the application of Moddus® and Kelpak® were recorded where the effect of plant density was studied, responses were inconsistent (Table 2). This was most probably due to the non-uniformity of plant density. However, these effects were not repeated in either 2016 or 2017.



## Die alles-in-een-saadverskaffer

### Kanola, die ideale wisselbougewas

Dit is bekend dat wisselbou met kanola vir verhoogde opbrengste by opvolggewasse soos mielies, sigorei, koring en selfs grastipe weidingsgewasse sorg. Daarby is kanola ook 'n besonder geskikte weidings- en kuilvoergewas. Dus kan kanola as deel van 'n wisselbouprogram baie voordelig wees.

K2 Saad bied 'n verskeidenheid kanolakultivars met eiesoortige eienskappe. Hyola 61 en Hyola 50 (konvensioneel), Hyola 575 CL (Clearfield) en Hyola 555 TT (Triazine) - almal geskik vir graan en weiding, is die verskeidenheid vroeg tot medium-laat tipe kanolakultivars beskikbaar vanaf K2 Saad.

Kontak gerus jou naaste K2-verteenwoordiger vir meer inligting.





**Table 3: Number of pods per plant of canola during 2015 at different localities in response to chemical treatments at budding (start of stem elongation) compared to treatments at budding and start of flowering.**

|                              |          | Altona | Langgewens | Roodebloem |
|------------------------------|----------|--------|------------|------------|
| Spray at budding             | Control  | 104d   | 86d        | 74cd       |
|                              | Kelpak 1 | 118c   | 108ab      | 83abc      |
|                              | Kelpak 2 | 128ac  | 106b       | 80bc       |
|                              | Moddus 1 | 119c   | 118a       | 83abc      |
|                              | Moddus 2 | 130a   | 106bc      | 81bc       |
| Spray at budding + flowering | Control  | 100d   | 86d        | 68d        |
|                              | Kelpak 1 | 133a   | 113ab      | 86ab       |
|                              | Kelpak 2 | 127abc | 106bc      | 82bc       |
|                              | Moddus 1 | 120bc  | 103c       | 92a        |
|                              | Moddus 2 | 121abc | 104bc      | 90ab       |

Kelpak 1 = 2ℓ/ha; Kelpak 2 = 4ℓ/ha; Moddus 1 = 0,4ℓ/ha; Moddus 2 = 0,8ℓ/ha

Means in the same row for each treatment with at least a common letter are not significantly different,  $LSD_{0.05}$

### Number of pods per plant

When sprayed at budding stage, the application of Moddus® and Kelpak® resulted in a significantly higher number of pods per plant at Altona and Langgewens, but not at Roodebloem during 2015 (Table 3). When sprayed at both budding and flowering stage, Moddus® and Kelpak® applications increased the number of pods per plant at all localities; in contrast to spraying at budding stage only,

dosage rate did not have an effect.

When applied to plots with less than 40 plants/m<sup>2</sup> (low plant density), the application of Moddus® and Kelpak® at all dosage rates resulted in a significantly higher number of pods per plant at Altona and Roodebloem, but only at high dosage rates of Kelpak® at Langgewens.

In plots with more than 70 plants/m<sup>2</sup> (high plant density), applications of Moddus® and Kelpak® did not have any effect on

the pod numbers at Langgewens, while at Altona higher pod numbers were only recorded at high dosage rates of Moddus®. At Roodebloem all rates of Moddus® and high dosage rates of Kelpak® showed a higher number of pods per plant. These positive responses were unfortunately not repeated in 2016 or 2017.

### Grain yield

Due to the low rainfall during the growth season, grain yields of less than 2 000kg/ha canola were recorded at especially the lower rainfall localities of Langgewens and Roodebloem during 2015.

At Langgewens increases in grain yield due to the application of Moddus® and Kelpak® were only recorded when double the recommended rates were applied at budding and start of flowering during 2015. At Altona all Moddus® and Kelpak® applications, apart from Kelpak® at high application rates and Moddus® at low application rates in plots with less than 40 plants/m<sup>2</sup>, resulted in significant increases in grain yield during 2015 (Table 4).

At Roodebloem all Moddus® and Kelpak® applications, except for Kelpak® at a low dosage rate in high plant density plots, resulted in significantly higher grain yields when compared to the unsprayed control plots.

Although rainfall during 2016 was very close to long-term averages, these

**Table 4: Grain yield (kg/ha) of canola during 2015 at different localities in response to chemical treatments at budding (start of stem elongation) compared to treatments at budding and start of flowering.**

|                              |          | Altona |         |      | Langgewens |         |      | Roodebloem |       |       |
|------------------------------|----------|--------|---------|------|------------|---------|------|------------|-------|-------|
|                              |          | 2015   | 2016    | 2017 | 2015       | 2016    | 2017 | 2015       | 2016  | 2017  |
| Spray at budding             | Control  | 1941c  | 1242bc  | 937a | 1233abc    | 1414bcd | 774a | 1205cd     | 1180a | 2035a |
|                              | Kelpak 1 | 2431a  | 1231bc  | 933a | 1302ab     | 1586abc | 940a | 1560a      | 1142a | 2195a |
|                              | Kelpak 2 | 2406b  | 1209bc  | 963a | 1273ab     | 1539abc | 845a | 1549a      | 1120a | 2226a |
|                              | Moddus 1 | 2135b  | 1132bc  | 899a | 1248abc    | 1659ab  | 945a | 1515ab     | 1232a | 2224a |
|                              | Moddus 2 | 2121b  | 1205bc  | 880a | 1245abc    | 1603ab  | 949a | 1495ab     | 1247a | 2106a |
| Spray at budding + flowering | Control  | 1936c  | 1331abc | 956a | 1172bc     | 1273d   | 733a | 1196d      | 1035a | 2065a |
|                              | Kelpak 1 | 2403a  | 1270bc  | 912a | 1254abc    | 1361cd  | 776a | 1371b      | 1070a | 2048a |
|                              | Kelpak 2 | 2447a  | 1544a   | 902a | 1355a      | 1761a   | 729a | 1431ab     | 1066a | 2171a |
|                              | Moddus 1 | 2143b  | 1388ab  | 960a | 1110c      | 1653ab  | 851a | 1386b      | 1046a | 2128a |
|                              | Moddus 2 | 2134b  | 1345abc | 822a | 1375a      | 1462bcd | 783a | 1519ab     | 1216a | 2041a |

Kelpak 1 = 2,0ℓ/ha; Kelpak 2 = 4,0ℓ/ha; Moddus 1 = 0,4ℓ/ha; Moddus 2 = 0,8ℓ/ha

Means in the same row for each one treatment with at least a common letter are not significantly different,  $LSD_{0.05}$

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- Potato **B4498**
- Vegetable **B4500**

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|                                    | Reg. no. | Zn%  | Cu% | Mn% | Fe% | Mo% | B%  | Total % |
|------------------------------------|----------|------|-----|-----|-----|-----|-----|---------|
| Grain Crops, Oil & Protein Seeds   | B4501    | 22.4 | 0.6 | 1.7 | 2.6 | –   | 1.3 | 28.6    |
| Potato – Foliar Application        | B4498    | 8.0  | 1.1 | 2.0 | 2.6 | 0.4 | 5.9 | 20.0    |
| Vegetable Crops – Soil Application | B4500    | 9.9  | 1.0 | 5.6 | 2.0 | 1.2 | 2.2 | 21.9    |

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**Table 5: Grain yield (kg/ha) of canola during 2015 at different localities in response to chemical treatments on low- and high-density crops.**

|                    |          | Altona  |        |      | Langgewens |         |      | Roodebloem |        |       |
|--------------------|----------|---------|--------|------|------------|---------|------|------------|--------|-------|
|                    |          | 2015    | 2016   | 2017 | 2015       | 2016    | 2017 | 2015       | 2016   | 2017  |
| Low plant density  | Control  | 1988c   | 870bc  | 808a | 1220a      | 1290bc  | 927a | 1190f      | 947b   | 1940a |
|                    | Kelpak 1 | 2404ab  | 722c   | 909a | 1239a      | 1233c   | 783a | 1627a      | 1195ab | 2088a |
|                    | Kelpak 2 | 2244bcd | 797c   | 768a | 1202a      | 1332abc | 937a | 1714a      | 1195ab | 2033a |
|                    | Moddus 1 | 2138cde | 855bc  | 819a | 1225a      | 1425abc | 990a | 1418cd     | 1160ab | 2077a |
|                    | Moddus 2 | 2074de  | 787c   | 865a | 1197a      | 1310abc | 898a | 1530abc    | 1064ab | 1934a |
| High plant density | Control  | 2083de  | 1088ab | 908a | 1269a      | 1556a   | 834a | 1248ef     | 1105ab | 1893a |
|                    | Kelpak1  | 2371ab  | 1284a  | 976a | 1339a      | 1518ab  | 882a | 1357de     | 1081ab | 1992a |
|                    | Kelpak 2 | 2439a   | 923bc  | 880a | 1358a      | 1486abc | 875a | 1615ab     | 1221a  | 2138a |
|                    | Moddus 1 | 2382ab  | 1075ab | 998a | 1245a      | 1469abc | 866a | 1638ab     | 1052ab | 2095a |
|                    | Moddus 2 | 2264abc | 1052ab | 862a | 1252a      | 1427abc | 896a | 1663ab     | 1074ab | 2002a |

Kelpak 1 = 2,0ℓ/ha; Kelpak 2 = 4,0ℓ/ha; Moddus 1 = 0,4ℓ/ha; Moddus 2 = 0,8ℓ/ha

Means in the same row for each one treatment with at least a common letter are not significantly different, LSD<sub>0.05</sub>

more favourable climatic conditions were not reflected in higher grain yields as opposed to that measured in 2015, except for the Langgewens locality (Table 4), which was most probably due to the late start of the rainy season.



Chemical treatments with Moddus® and Kelpak® at budding or budding and flowering had very little effect on grain yield at Altona and Roodebloem, but both Moddus® at the recommended rate and Kelpak® at double the recommended rate increased grain yields when applied at budding and the start of flowering at Langgewens during 2016.

When applied to canola plants at either low planting densities (< 40 plants/m<sup>2</sup>) or high planting densities (> 70 plants/m<sup>2</sup>), chemical treatments had no effect (Table 5).

Due to very dry conditions grain yields of less than 1 000kg/ha were recorded at Altona and Langgewens during 2017. Chemical treatments with Moddus® and Kelpak® had no significant effect on grain yield, regardless of dosage rate or time of application and planting densities (Table 5).

Although yields at the Southern Cape locality of Roodebloem were higher than 2 000kg/ha due to more favourable growth conditions – in contrast to especially 2015 when grain yields of more than 1 500kg/ha were attained – no significant

differences due to chemical applications of Kelpak® and Moddus® were recorded.

### Conclusions

- Moddus® as a plant growth regulator reduces plant height.
- Both Moddus® and Kelpak® stimulated the production of flower heads and pods per plant, resulting in higher grain yields per hectare.
- Plant responses to treatments with these chemicals were, however, not consistent and differed between localities and even between years on the same locality.
- The lack of more conclusive results may be due to poor growing conditions experienced in most trials of this study, which prevent the production of tall bulky crops prone to lodging.
- More consistent results may be expected when applied to canola grown under irrigation, where tall growing plants and high biomass are produced. 🌱

Send an email to Prof André Agenbag at [pns@proteinresearch.net](mailto:pns@proteinresearch.net) for more information and references.

# Site-specific management of in-field spatial and temporal variability of soils

By Prof ME Moshia, specialist researcher ARC-ISCW

**A**gricultural production has traditionally been optimised for profit. Nevertheless, this has been changing gradually due to increasing pressure for agribusiness practices to meet certain environmental standards.

With the adoption of precision agriculture or site-specific farming practices, every part of the field is treated individually as opposed to treating the whole farm as one unit with homogeneous soil type, slope, texture, pH, and more.

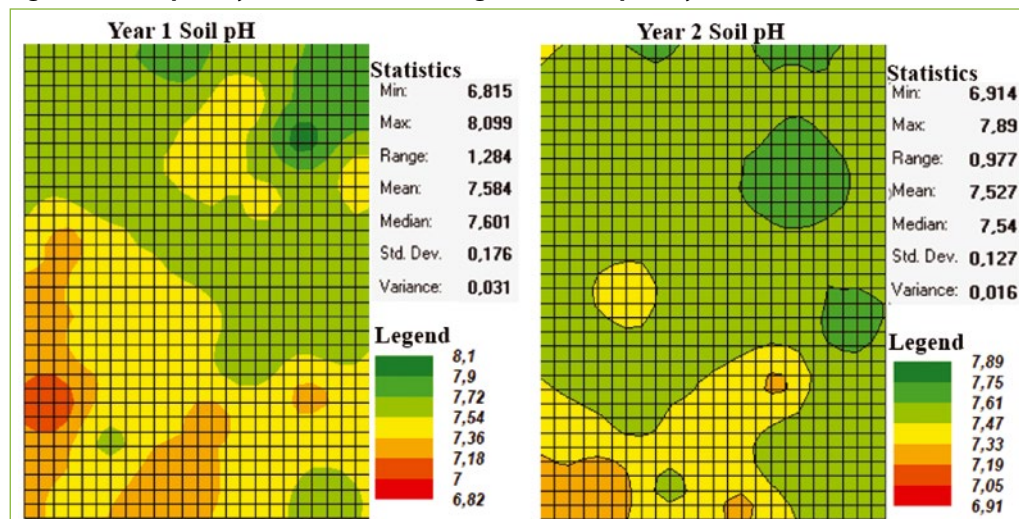
The eventual goal of precision agriculture is to manage spatial and temporal variability associated with all aspects of agricultural production for optimum profitability, sustainability, and protection of wildlife and the environment. Spatial variability is when one part of the field produces more, while another part of the same field produces a decreased yield in the same year/season.

## Variability must be managed

Temporal variability is when an agricultural field produced 17 ton/ha in 2016, 13 ton/ha in 2017, and suddenly 10 ton/ha in 2018. Yield varies over the years. Both spatial and temporal variability in an agricultural field must be managed, and the causes of variability must be established through soil surveys.

Figure 1a and 1b show a change in soil pH from year one to year two; that is temporal variability – changes over time or across years. In the same picture we can see different soil pH levels in year one ranging from acidic soils (pH = 6,82) to alkaline soils (pH = 8,09). When you have

**Figure 1a: Soil pH of year one in field A. Figure 1b: Soil pH of year two in field A (same field).**



acidic and alkaline soils in the same field, lime must be applied variably with the use of a navigation system such as a differential global positioning system (DGPS).

DGPS is a GPS system that communicates with satellites and have sources of GPS errors removed (Figure 2), as opposed to a

**Figure 2: Differential global positioning system (DGPS).**



handheld Garmin GPS (Figure 3) that has an accuracy of around 15 metres or more. With DGPS, there is an annual subscription with private companies; handheld GPS units do not have a differential correction and there is no annual subscription fee.

Precision agricultural technology attempts to answer profoundly debated global issues of concern such as soil erosion, increasing demand for food due to the increasing world population, the unstable world economy, and the environment.

**Figure 3: Handheld Garmin GPS (no differential correction).**





Comparable to many other inventive developments in the sciences, precision agriculture is, for the most part, a byproduct of the amalgamation of massive investments in science, a productive intellectual culture, and global socio-political conditions.

### Traditional farm management

The reported adoption of precision agricultural technology globally has been slower than estimated, because proper decision-support systems that will aid the implementation of decisions based on precision agricultural technology are lacking.

This whole-field traditional farm management ignores spatial variability and assumes that 'average' conditions are the same everywhere in the field. Whole-field uniform management is based on broad averages of field data with management actions directed by 'typical' conditions.

Suppose a farmer relied on an average soil pH. It means the farmer would treat the field as having slightly alkaline soils and entirely ignore the fact that some areas of the field have a soil pH of 8, where availability of essential maize nutrients such as zinc, manganese, copper, and iron could be affected (Figure 4).

Unlike precision agriculture, traditional farm management systems lack the technology to understand in-field variability to manage crop production systems accordingly. Instead, farmers apply lime, fertilisers, pesticides, water, and other agricultural production inputs uniformly across the field.

In a field with spatial variability of soil properties it was reported that uniform application of lime, or fertilisers such as nitrogen (N) and phosphorus (P), often results in various areas of the field receiving greater farming inputs than is necessary.

Phosphorus runoff and N leachate from over-fertilised areas may contaminate the ground and surface water supplies, while crop yield may be restricted in under-fertilised areas. In one of the studies conducted with N fertilisers and animal manure, it was observed that precision agricultural techniques have the potential to reduce environmentally sensitive nutrient loads into the environment.

### Who can adopt precision agriculture?

Any farmer with a field that has a spatial variability of soil properties or yield limiting factors, meaning that soil properties change as a farmer moves from one part of the field to another. The field's spatial variability has to be significant enough to affect yield and farm economics; however, the size of the field does not matter.

Some of the methods to determine the existence of spatial variability and yield limiting factors are soil surveys and mapping, which determine all soil types occurring on the farm. Soil depth, soil texture across the field, and subsoil clay content are essential to determine, especially on irrigated fields.

Previous yield maps can show variability in yield. Topography/slope maps can give a hint because it is a fact that different soils

occur at different landscape positions, or across slopes.

Free satellite images of agricultural fields are available on the Internet. Scan the images you have selected back into the computer and convert them to greyscale (not black and white) – areas that appear lighter are said to have more sandy soil

and low organic matter content, while areas appearing darker could have more clay soil and organic matter content.

Draw/zone out those areas with pencil on a paper map and, using a GPS, navigate to those areas in the field to check/verify soil texture, soil depth, and other soil characteristics.

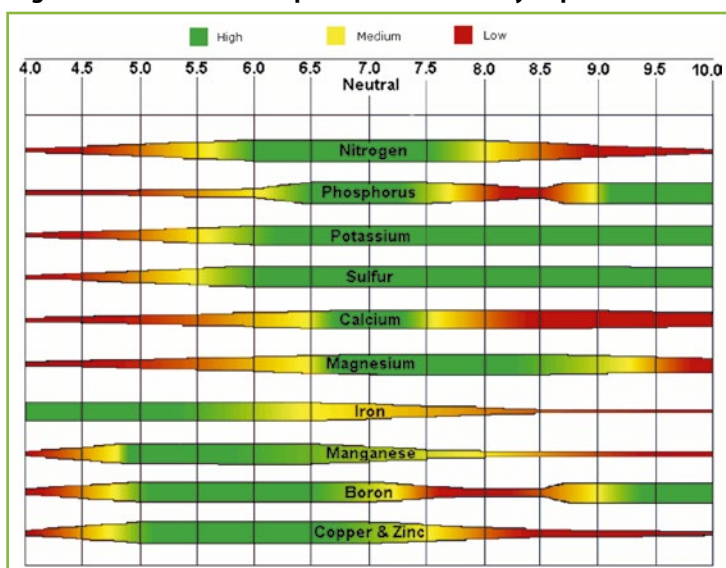
### Myths about precision agriculture

The following myths about precision agriculture are not true:

- Precision agriculture uses expensive and complicated equipment that is not easy to operate.
- Implementing precision agriculture is expensive.
- You need a bigger field to implement precision agriculture.
- Precision agriculture is for American and European farmers.
- It is not easy to implement precision agriculture in Africa.
- There are no people in South Africa who are educated enough to help farmers.

At ARC-ISCW we conduct training on soil surveys, GPS/GIS applications and precision agriculture, and offer services related to data management. We can help farmers determine the degree of spatial variability, acquisition and manipulation of satellite images to understand in-field spatial variability, land suitability assessment, soil analysis, mapping of agricultural fields, implementation of precision agriculture, and delineation of management zones. 🌱

**Figure 4: The effect of soil pH on the availability of plant nutrients.**



Prof ME Moshia is a specialist researcher in soil information systems at the Agricultural Research Council – Institute for Soil, Climate, and Water in Pretoria. He holds a PhD in soil sciences, specialising in precision agriculture, from Colorado State University, US. He was a Fulbright Research Scholar in environmental soil sciences at the University of Florida, US. He is a rated researcher by NRF and represented South Africa at the International Society of Precision Agriculture for five years. He currently represents Africa at the FAO-Intergovernmental Technical Panel on Soils (2018-2021).

For more information, contact him on 012 310 2603 or email [MoshiaM@arc.agric.za](mailto:MoshiaM@arc.agric.za).

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Cover Crops Division



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

By Gerrie Trytsman, ARC-API, and Hendrik Smith, conservation agriculture facilitator: Grain SA

**B**efore 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.

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.



The layout of the trial.



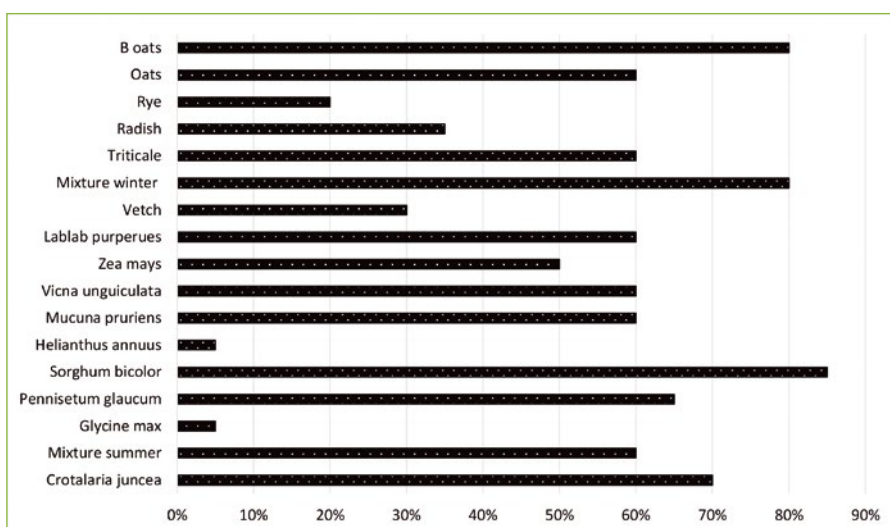
*Trial sites in Ottosdal during the drought of the 2014/15 season. This photograph taken on 16 February 2015 clearly indicates the effect of the drought. Some sites showed withering during pollination.*

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

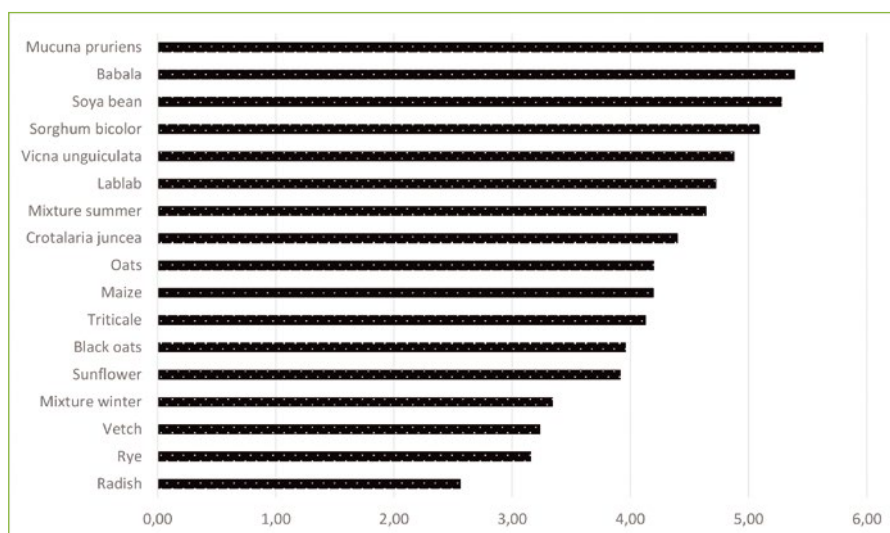


example and compared to the yields of the previous planting season, it is approximately 80% lower. However, the summer crops babala and forage sorghum are in good condition, as well as the summer legumes such as velvet beans, cowpeas and lablab, which are all doing very well in low rainfall conditions.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

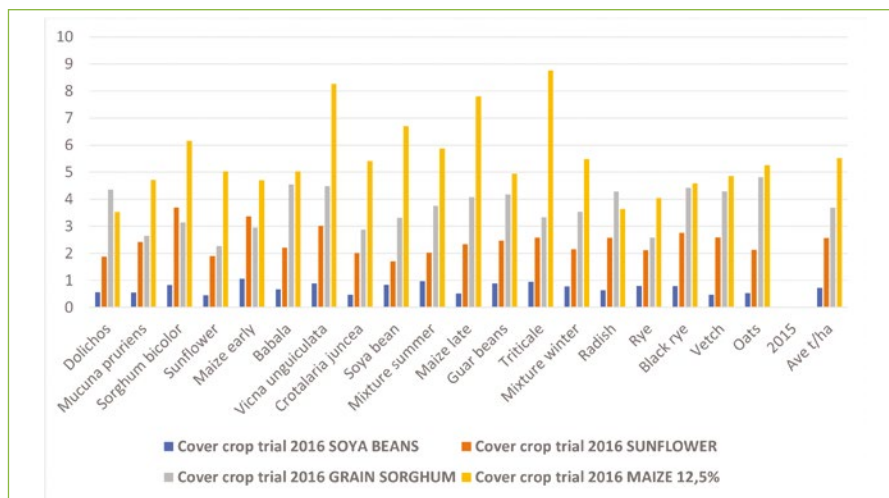
**Figure 2: Average dry material (DM) yield of crops in the 2014/15 season.**



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 trials 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.



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# SENSAKO presents

## oilseed winners to the market



By Willem Otto and Roëan Wessels, Sensako

*As a proudly South African company, Sensako aims to develop competitive seed products for the local market in a bid to help keep producers profitable. The well-known brand is making its return to the summer crop market with three adapted SSS soya bean cultivars and the Clearfield sunflower hybrid SY 3970 CL.*

The soya bean cultivars recently released by Sensako for production in South Africa, originate from the breeding programme of Argentina's Estación Experimental Agroindustrial Obispo Colombres (EEAOC) – the country's oldest agricultural research station. It was established in 1909 with the aim of improving and supporting agricultural production in the Tucumán province through research and extension services.

### Development of soya beans

Since its inception, the institution has been playing a major role in the development of new crops for the area. Today, EEAOC continues to introduce quality cultivars for several production areas through ongoing and effective research by its team of experts.

The cultivars and advanced breeding lines developed by EEAOC were extensively tested in statistical trials in the local soya bean production areas over time. The Sensako trial programme is visited annually

by the EEAOC research team to evaluate statistical trials and seed production.

Soya bean cultivars (indeterminate growers with Roundup Ready resistance) released from the programme have excellent agronomic characteristics, different maturity groupings (6,0, 5,8 and 5,2) and can adapt in different environments.

Independent results from commercial strip trials, in conjunction with several study groups and farmers' associations, have also confirmed the exceptional yield performance, adaptation, stability and stress tolerance of these winning cultivars.

### Three adapted cultivars available

The range of SSS cultivars produced competitive yields compared to the control cultivars across all production seasons. Seed of these cultivars is commercially available for planting.

**SSS 6560tuc** – exceptional yield potential and adapted for warmer irrigation areas. Long grower, bush-like cultivar with exceptional yield potential adapted for the warmer irrigation, moderate and cooler areas as well as dryland production. Well suited for wider row widths.

**SSS 5052tuc** – stable and adapted high-yield potential cultivar for dryland and irrigation. A bush-like but more upright cultivar with good lodging resistance and resistance to shattering.

**SSS 5449tuc** – Eastern Highveld winner, adapted for high yield potential in the cooler dryland and irrigation areas. Semi-bushy cultivar with excellent

pod height and lodging resistance, as well as good resistance to shattering. Well suited for narrow row spacings.

Cultivar and growth class must be selected for maximum utilisation of the two main yield determining aspects: leaf area and duration (length of vegetative growth phase) and grain-filling period. The planting date is, of course, an inextricable part of the process as the daylight length pattern for the remainder of the season is directly linked to it.

### Soil water determines planting

Changes in the planting date necessitates an adjustment in the choice of growth class of a cultivar that will be least affected by the planting date. If planting is postponed to a later date, the row width and plant population should also be adjusted. Under dryland production conditions, the planting time is determined by soil water conditions, which, in turn, is affected by rainfall and cultivation activity.

When considering the available planting window, flexibility in cultivar choice is key. Choose the most suitable growth class and cultivar and adjust the row width and plant population to achieve the best yield reaction.

### Exciting sunflower hybrid

Sensako also offers a competitive yield in sunflower plantings with the Clearfield sunflower hybrid SY 3970 CL, developed by Syngenta. The tested effect of a focused product – yield plus better weed control – is a winning combination in cultivation.

The cultivar has excellent agronomic characteristics, good and stable yields in various production areas and resistance against prevailing diseases.



For more information on cultivar characteristics, yield results and seed availability for the next production season, visit [www.sensako.co.za](http://www.sensako.co.za).

# Canadian canola targets: Are we on par?

By Chris Cummings, Protein Research Foundation

**W**ith more than 18 million tons per year, Canada is undoubtedly the world leader in canola production, a position the country continuously strives to improve. One of the strategic objectives of the Canola Council of Canada is to achieve an average yield of 52 bushels per acre by 2025. This is equal to 3,26t/ha. Canada's current average is 2,13t/ha; an increase of 1,13t/ha is therefore needed to reach this goal.

South Africa's average yield in 2016 was 1,81t/ha, but there are producers who had yields of more than 3t/ha. Although an average of 3,26t/ha is quite far-fetched, 2,5t/ha is relatively achievable.

What does the Canadian strategic plan entail to reach their goal? It is based on targeting five clear production aspects, namely:

- Genetic improvement – 502kg per hectare (44,4 %).
- Plant establishment – 188kg per hectare (16,7 %).
- Fertilisation management – 188kg per hectare (16,7 %).
- Integrated pest management – 125kg per hectare (11,1 %).
- Harvest management – 125kg per hectare (11,1 %).

Let's look at each factor and determine if, realistically, we are on par.

## Genetic improvement

The Canadians have a firm advantage in this area compared to our current situation. The fact that their canola industry is large (currently 9 265 812ha) means that all major seed companies in the country are competing for a share of the market. Canadian producers cultivate mostly GMO cultivars with several beneficial built-in properties, such as herbicide tolerance, shattering resistance and disease resistance.

Although our canola seed is imported mostly from Australia we have access to the best non-GMO hybrid cultivars, which have proven over many seasons that they have the potential to produce more than three tons per hectare.

In recent discussions between the PNS, Grain SA and seed companies, companies that import canola seed have committed themselves to making the preferred cultivars even more accessible to South African producers. In addition, they will put plans in place to ensure that sufficient seed quantities are available annually. Genetic progress and the accompanying yield progress achieved in other countries will therefore find its way to South African canola producers.

If the average increase in yield from roughly 1t/ha to 1,81t/ha over the past ten years is considered, and the increase can mainly be attributed to

improved cultivars, it can be assumed that South Africa's canola yield will keep on increasing due to improvements in genetics. *Figure 1* provides a summary of the yield per hectare and total surface area planted. It is clear that the yield per hectare, like Canada, increased over the past few seasons.

It is noted that Triazone Tolerant (TT) cultivars reduce yields by approximately 20% compared to Clearfield and conventional hybrids. Several of the TT cultivars are planted in the Swartland, specifically, because of herbicide resistance. If this situation is considered, it becomes clear that potential yield increases are very achievable if weeds can be more successfully controlled, which will make the planting of TT cultivars unnecessary.

## Plant establishment

The notion of a smooth, even stand for a good canola harvest remains extremely important. Evenly developing canola that moves uniformly through the growth phases make many management decisions easier. Timing of pest spraying, cutting or direct harvesting are much easier with an evenly developed stand.

An even stand also contributes to weed suppression; especially difficult to control weeds that take longer to germinate.

Producers have made good progress with their planting techniques in respect of spacing, planting depth, etc.,



although fields where planting occurs in dry soil often have uneven emergence and establishment. Apart from uneven moisture conditions in the field, aspects such as dense ground cover consisting of crop residues, the quantity and placement of fertiliser during planting, and the control of insects and diseases that attack seedlings, add to uneven emergence and establishment. Improved plant establishment can therefore contribute to higher canola yields in South Africa.

Trifluralin, if applied correctly, is currently one of the most effective annual graminicides and is relatively inexpensive. It can be applied to dry soil, provided it is lightly worked into the soil. It controls all germinating grass seeds that occur in the treated zone for six to eight weeks and causes no damage to the canola seedlings.

Canola does not tolerate excess plant material on top of the plant row. If Trifluralin is worked into the soil a favourable seedbed is created that will aid germination.

black stem requires more attention, but fortunately the occurrence of the disease has been limited over the last few years. Seedling wilt diseases in general have not occurred, but should be carefully monitored.

Insect plagues (diamondback moth, aphids and bollworm) have occurred sporadically and at times caused severe damage that made the monitoring thereof essential. Proposed threshold values for spraying must be followed to ensure that any spraying is economically justifiable.

Predators and parasites that help keep pest populations in check must be kept in mind.

The insects that occur during and shortly after planting (isopods, snails, mites and aphids) are generally properly addressed, but regular monitoring in the first few weeks after emergence cannot be overemphasised. Although these aspects are the so-called small foxes, addressing them can bring about a significant increase in canola yields for South African producers.

### Harvest management

According to agronomists in the industry, harvest losses are still a real problem for some canola producers. The greatest losses

are attributed to the wrong cutting time as well as problems occurring when herbicides are sprayed directly after harvesting.

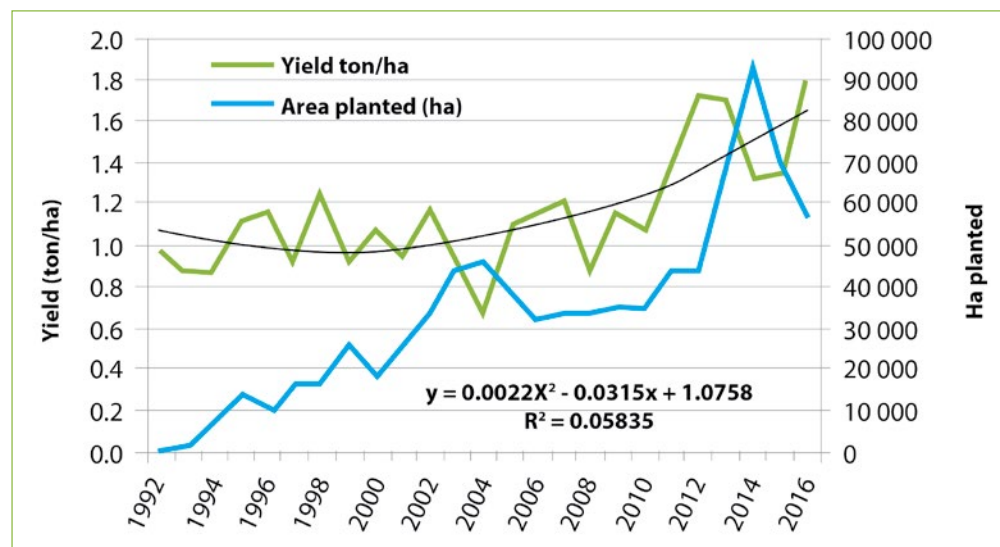
Losses during the harvesting process also occur. Estimated losses amount to between 50 and 250kg per hectare and have been confirmed by actual measurements at farm level. Correcting these problems without incurring additional costs for the producer, can increase canola yields and profit margins.

### In summary

I believe that if producers view canola as a cash crop in its own right and not just as a rotation crop planted to address problems, the average canola yield in South Africa, similar to the plans Canada has, can be increased dramatically.

By addressing the five points mentioned in this article and applying better management, producers will, without any additional input costs, be able to gain back that lost quarter to a half ton canola yield. This will certainly allow canola to take its rightful place. 🌱

**Figure 1: Canola yield and surface area planted in South Africa.**



### Fertiliser management

Because the hectares under canola in the Western Cape are fairly limited, funding for research is also limited. Canola's fertiliser needs per ton grain produced is higher than that of wheat. It is also important that the different elements are applied at the right time. Great progress has been made in respect of nitrogen, sulphur and boron, but more expertise regarding other macro- and micro-elements contribute to higher canola yields.

### Integrated pest management

In many areas, weed resistance still plays a dominant role in the selection of cultivars and weed control programmes. The choice of herbicide is even more difficult since a lot of canola is planted in dry soil. Although most producers are not in favour of full-area spraying and applying Trifluralin before planting canola, there are significant benefits.

There is no doubt about the benefits of conservation farming and minimum tillage, and these systems are fully supported.

However, if better weed control and possible use of conventional or Clearfield cultivars with higher yield potential are considered, a once-off light soil cultivation every fourth year to work Trifluralin into the soil before planting canola, poses more advantages than disadvantages.

Canola producers are well aware of the adverse effects of *Sclerotinia* on canola yields and most producers follow the recommended guidelines to combat it successfully. That said, time of application, which is critical for good control, can be improved in some cases.

Because *Sclerotinia* spraying is a relatively expensive input cost, it will be to the benefit of the farmer if everything is done correctly; water volumes, spraying equipment and good coverage of the petals goes without saying.

Alternating cultivars with different resistance genes to avert the danger of

# Effective inoculation of soya beans

By Johan Habig and Jeancy Mpenge, MicroLife Research Centre, Agri Technovation, Wellington

**T**here are symbiotic relationships between legumes and specific soil bacteria (rhizobium that enable legumes to utilise atmospheric nitrogen effectively.

It is very important to remember that soya beans are not native to South Africa. Therefore, it also means that the specific rhizobium responsible for the nitrogen fixation process, does not occur naturally in our country's soil. Because there is a very specific symbiotic relationship between the soya bean seed and the specific rhizobium, the producer must ensure that the right rhizobium is always available in the immediate vicinity of the seed/root. (Figure 1)



Inoculation involves the mixing of soya bean seeds with a compatible inoculant containing a very specific living rhizobium that provides nitrogen efficiently and directly to the soya bean plant.

Since rhizobium are not detrimental to the soil, it will not be harmful to inoculate every season when soya beans are planted. Another reason why soya bean seed should be inoculated every season during planting, especially where soya beans are used in a rotation system, is because soya beans are planted on a different portion of the farm/field every season, which can have a delay effect on the survival and build-up of the rhizobium in the soil. (Figure 2)



## The importance of nitrogen fixation

Biological nitrogen fixation is of economic importance for high protein content soya bean yields and is performed by two different groups of nitrogen-fixing bacteria: the free-living group (*Azotobacter* and *Azospirillum*) that provide nitrogen to non-legumes, and the symbiotic rhizobium that form nodules on the roots of legumes. (Figure 3)



Soya bean seed is mainly inoculated with a very specific living nitrogen-fixing bacteria (rhizobium), *Bradyrhizobium japonicum*. The breed WB74 has already been named the best inoculation breed for South African conditions.

## Dry and liquid inoculants

Inoculants pose no "danger of pollution". Before inoculation, individual packets from different packages can be merged to reduce variation in quality.

The inoculation process of seed with inoculants can take place in large quantities



in concrete mixers or drum mixers. (Figure 4) The mixers should just contain no chemical weed killer, insecticide or fungicide. Molybdenum-enriched adhesive should usually be added when seed-inoculation is mixed with dry or liquid inoculants.

The living rhizobium in inoculants are very sensitive to environmental conditions such as direct sunlight, soil pH, moisture, temperature and dissolved salts. As soon as soya beans experience stress conditions, it can reduce or stop nitrogen fixation, or even wean some of the nodules. (Figure 5)



Moisture should therefore be applied as soon as possible after the planting process to prevent drying out of the living rhizobium.

As an alternative, diluted suspensions of the inoculant (diluted liquid inoculant or water suspension of the powder inoculant) can be placed under the seeds in the plant furrow during the planting process. It promotes early nodule formation. Irrigation after the planting process is consequently less critical.



Clean unchlorinated water is needed to make up the suspensions in clean containers/tanks that do not contain pesticide or herbicide residues. Planters with spray equipment must also be adjusted to accommodate this application method.

Users should be careful not to mix chemical fertilisers with the rhizobium. Keep in mind that the presence of mineral nitrogen in the soil can also delay or prevent nitrogen fixation.

### A healthy soya bean plant

Soya beans that have been inoculated effectively display healthy dark green foliage. If leaves are a light green colour, something is wrong (Figure 6). To make sure that the inoculation was successful, the soya bean plants can be dug out (not pulled out) to study the roots. Nodules should be visible on the radicle two to three weeks after emergence.



Well-defined nodules can be observed after four to five weeks on the crown and main roots. (Figure 7) The inside of active nodules is pink/dark red.

Producers should be careful not to apply any biological products with rhizobium that can out-compete the inoculated rhizobium in the soil.



### The FurrowLife difference

During trial plantings in Middelburg, Agri Technovation's product FurrowLife was

applied with inoculated soya bean seed. It contributed to a 25% increase in root nodule diameter, and a 82% increase in the number of root nodules. Successful nitrogen fixation can provide more than 280kg/ha nitrogen directly to the plants, while follow-up crops such as maize can produce 20% higher yields as a result of nitrogen left behind in the soil.

Root nodules remain active until flowering, after which they become inactive. Tip: If a nodule of a soya bean root comes off easily, it is a rhizobium; if it does not want to come off, chances are good that it can be root-knot nematodes. (Figure 8) Be careful not to confuse the two.

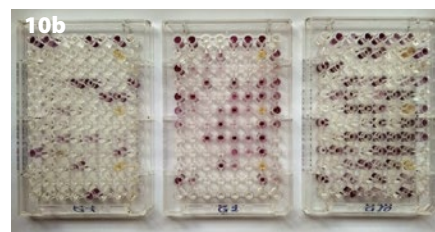


Ideal conditions for biological nitrogen fixation require a soil pH of 5,5 to 7,5 and more than 17ppm phosphate as well as micro-amounts of molybdenum.

### Important points about inoculant

Inoculant must be registered in terms of the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947). This data should be clearly visible on the inoculant label together with the lot number, expiry date and the quantity of rhizobium cells present. (Figure 9)

Users must ensure that the product has not yet expired, that the rhizobium numbers within the inoculant packet are still pure and viable, and that there are sufficient quantities. Inoculants should be stored away from toxins and direct sunlight at a temperature of 4 to 27°C.



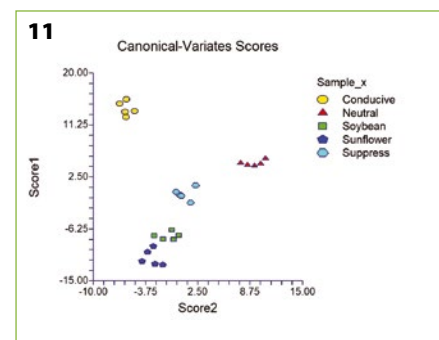
### A research centre par excellence

MicroLife Research Centre is Agri Technovation's first microbiology laboratory that offers soil health analyses on commercial scale to producers and academic and research institutions. Strategic combinations of microbiological analyses are used as indications of soil health. (Figure 10a and 10b)

These results are then also correlated with organic and active carbon to get an indication of the state of soil health. (Figure 10c)



Because agricultural practices such as crop rotation systems, soil cultivation and compost-/soil conditioner application affect soil health, regular soil sample analyses can help to compile unique microbial profiles over time. It contributes to customised solutions for each producer's specific combination of agricultural practices.



The producer can use the results to make informed decisions in time to promote sustainable long-term production. (Figure 11)

# Certified seed – your first defence against *Sclerotinia* in soya beans

By Hanlie du Plessis

**S**clerotinia, a sporadic fungal disease affecting a wide range of host plants, had a substantial impact on soya bean production the previous season. This fungus can potentially reduce soya bean yields by up to 50%, should conducive environmental conditions for the infection and rapid development of the disease prevail during the growth period.

Unfortunately, by the time the first *Sclerotinia* symptoms are observed, very little can be done to control the fungus. Preventative management practices should therefore be implemented and applied to minimise the level of infection and further spread of the disease.

One of the early symptoms of *Sclerotinia* disease is the sudden wilting of soya bean plants. Leaves will turn greyish-green before turning brown, curling up

and eventually dying off. The fact that the leaves do not drop immediately makes it easier to distinguish infected plants from healthy ones. Symptoms will normally be visible within two to three weeks after flowering has commenced in the crop, if the right conditions persisted and infection has occurred.

*Sclerotinia* can easily be distinguished from most other soya bean diseases by the presence of a white, cottony, mouldy growth and hard, black sclerotia on the inside and outside of infected stems and pods. The black sclerotia are the survival structures of *Sclerotinia* and can easily be spread during harvesting.

The fact that sclerotia can survive in the soil for a period of between four to seven years, while awaiting favourable conditions, makes it even more difficult to contain this disease. The most favourable conditions for the fungi to develop are during the flowering stages, with high rainfall and cool temperatures of below 28°C.

The development of the disease occurs primarily after the closing of the leaf canopy, which promotes cool temperatures and creates a humid microclimate around the stems of the plants. High soil moisture because of rain or irrigation contributes significantly in creating the favourable microclimate underneath the closed canopy.

## Farm-saved seed

*Sclerotinia* spores and sclerotia are widely found across South Africa. Some management practices conducted by farmers may, however, contribute towards the build-up of these bodies in the soil. The biggest culprit is farm-saved seed.

Chances are that the seed of the grain harvested the previous season have not been subjected to testing for quality properties. If the commercial production was infected with *Sclerotinia*, the sclerotia harvested together with the grain will be planted along with the farm-saved soya bean 'seed'.

There are different opinions on the reasons for the sudden increase in *Sclerotinia* occurrence. Whitey van Pletzen, production manager at Agricol and chairperson of the





### Good management practices against *Sclerotinia* infection used by seed production companies include:

- **Cultivar selection:** A number of cultivars have proven to be either more tolerant or more susceptible to *Sclerotinia* infection than others. This information, obtained through internal product research, can usually be obtained from the seed companies marketing those cultivars.  
There is currently no soya bean cultivar known to be completely resistant to *Sclerotinia*. The use of more tolerant cultivars is an effective tool in managing the disease. Avoid planting highly susceptible cultivars in fields with a history of *Sclerotinia* infection.
- **Plant population and general planting direction:** Unfortunately, producers follow production practices that can often create the ideal microclimate and environment for diseases to develop. Some of the following practices are associated with high infection rates: narrow row spacing, high seeding rates, late planting dates, and over-application of nitrogen.  
Cultivation practices used should discourage the formation of a cool and humid microclimate where *Sclerotinia* can thrive. Wider rows and planting from north to south will allow sunlight into and the movement of air between the rows, especially after irrigation or spells of rain.  
Soya bean plants are very adaptable and known to compensate in cases where lower seeding rates are observed.
- **Crop rotation:** *Sclerotinia* has a wide host range including soya bean, dry bean, potatoes, peas, cucumbers and some common weeds, to name a few. Crop rotation towards non-susceptible crops such as maize and sorghum can help to reduce the level of sclerotia occurrence in the soil. Rotation crops need to be planted for at least three consecutive planting seasons before soya beans can be reconsidered on the same field.
- **Weed control:** Several broadleaf weeds are known to be *Sclerotinia* hosts and aid in the spread of the disease. A well-planned spray programme should be followed as recommended by chemical sales agents.
- **Fertility and plant nutrition:** High soil fertility, especially the use of nitrogen-rich manure and fertilisers, favours *Sclerotinia* development by promoting lush plant growth and early canopy closure. Having soil fertility tests conducted on a regular basis will help avoid over-fertilising fields that are prone to *Sclerotinia* infection.
- **Irrigation management:** Excessive irrigation, above what is needed to maintain yield potential, should be avoided during flowering to minimise moisture in the soil surface and below the crop canopy. Low moisture levels within the soya bean canopy are critical for reducing the potential for infection. Occasional, heavy watering is better than frequent, light watering. Avoiding excessive irrigation is especially important during the critical periods of infection, such as the early flowering to early pod development stages.
- **Chemical control:** Chemical applications can be a component of an integrated management system for *Sclerotinia*. Some foliar-applied fungicides and herbicides are effective against *Sclerotinia*, although none of them offer complete control.
- **Harvesting:** As previously mentioned, sclerotia are often distributed by combine harvesters. It is therefore imperative to leave the fields where the fungus has been observed to be harvested last.

South African National Seed Organization's (Sansor) Seed Certification Standing Committee, is of the opinion that the only effective way to manage *Sclerotinia* is by following an integrated process of best farming practices.

### Insist on certified seed

Start by planting healthy, good quality certified seed. The fields on which seed companies produce certified seed are subject to regular inspections throughout the planting, production, harvesting, cleaning and packaging process.

Seed samples of registered seed lots are taken by authorised seed samplers for various tests to be conducted. Field inspections, sampling and quality testing must be done according to internationally accepted, validated methods and procedures. Seed testing is important to assess the quality of seed marketed to producers.

Kobus van Huyssteen, technical officer at Sansor, explains the thorough and lengthy process of seed certification: "Certified seed must meet additional and stricter requirements than other seed. The process, with more than 90 control points, exercises control over breeder seed through pre-basic, basic and finally certified seed multiplications and aims specifically to guarantee cultivar purity and cultivar identity, as well as seed of good physical quality."

Sansor will only certify seed lots that have been produced on fields registered with Sansor and produced according to the specifications and requirements of the SA Seed Certification Scheme. During the registration process the origin of the seed is verified to ensure that it is acceptable for certification.

### Inspected by trained inspectors

Field inspections – during which several aspects such as varietal purity and isolation distances are controlled – are conducted by trained and authorised seed inspectors. After harvesting, processing and packaging, the seed is sampled and tested by registered seed testing laboratories to assess the germination potential and physical purity of the seed lots.

Post-control grow-outs are planted by the Department of Agriculture, Forestry and Fisheries (DAFF) to verify the varietal purity and identity of the production unit.

BP Greyling, a mega farmer and Agricultural Writers SA's Farmer of the Year 2011, farms on Langfontein near Wakkerstroom in Mpumalanga. His opinion on the use of certified seed is: "I have planted soya beans for the past 32 years. I cannot say that I've never had *Sclerotinia* on my farm, but I can say that in 32 years I've never had *Sclerotinia* on any field where I've planted certified seed."

He is convinced that buying certified seed is the first and most important step towards keeping soya bean fields free of *Sclerotinia*.

### Going forward

More research is needed to effectively manage this dreaded disease, with a special focus on the breeding of more resistant cultivars, biological control agents and integrated disease management systems. 🌱

# Application of CRISPR technology in agriculture

By Ursula Human

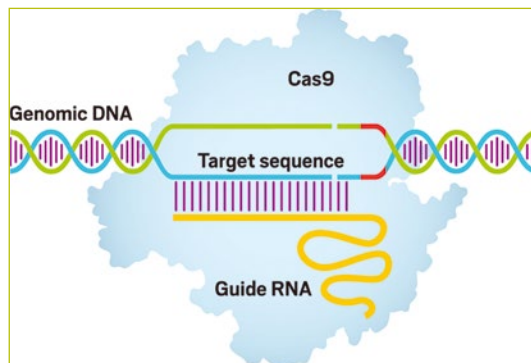
**T**he new gene editing technology known as CRISPR (pronounced 'crisper' and short for clustered regularly interspaced short palindromic repeats) has been making headlines in the agricultural sector for some time now. This new technology makes gene editing faster, more affordable and more precise as opposed to conventional genetic modification (GM) processes such as cisgenesis and transgenesis.

Cisgenesis genes by comparison are artificially transferred between organisms that could have been bred conventionally; transgenesis introduces genes from outside the plant or animal's genome.

CRISPR is a powerful tool that could potentially wipe out genetic disease in plants, animals and humans, as well as improve drought resistance and enhance nutrition in crops. But how does it work and how could it be applied in the agricultural industry? Also, will regulations allow it to be applied on a global scale to really reap the benefits this technology could potentially offer the world?

## How it works

In 2012, scientists Emmanuelle Charpentier and Jennifer Doudna discovered the use of a unique characteristic in the immune systems of prokaryotic organisms, such as bacteria and archaea, that allowed them to edit



Using CRISPR to edit genes involves making a cut in the DNA of organisms using molecular scissors, which enable breeders to edit genetic traits. (Source: Chemical & Engineering News)

genes in other organisms. In 2013, its application as a genome editing tool in plants was successfully achieved.

CRISPR entail DNA sequences found within the genomes of prokaryotic organisms, that allows them to protect themselves against foreign genetic elements such as viruses. This gene editing technology is often referred to as CRISPR/Cas9, which means that it contains

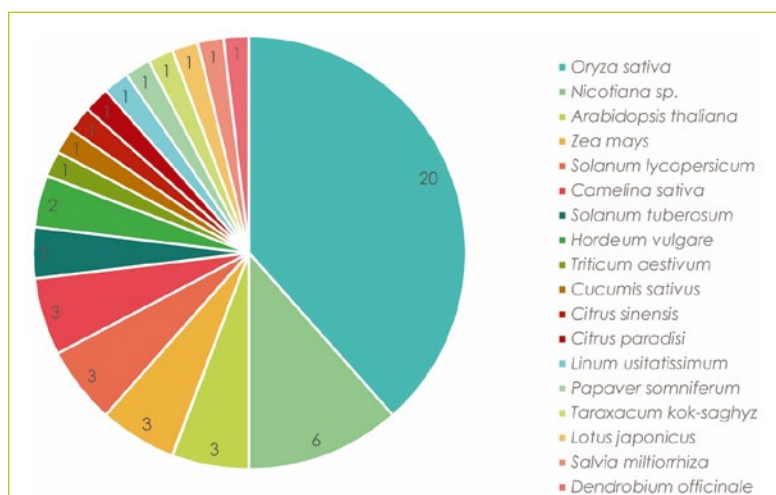
protein clusters known as Cas9 and CRISPR-RNA (crRNA). The Cas9 acts as the 'gene scissors' and the crRNA guides the 'scissors' to edit the DNA at the right position. For the sake of simplicity, the generic term CRISPR will be used unless otherwise specified.

The genomes of prokaryotic organisms essentially allow these organisms to cut out the part of DNA that has been affected by a virus. The organism retains snippets of the virus DNA from previous attacks and uses CRISPR/Cas 9 to find and cut the virus's DNA.

Scientists use this to edit genes in other organisms. It involves making a cut in the DNA using molecular scissors that allow breeders to insert, delete or replace genetic traits within an organism's genome. The changes to the DNA sequence are then accepted by the organism's natural repair process, thus becoming part of the organism's genomic sequence.

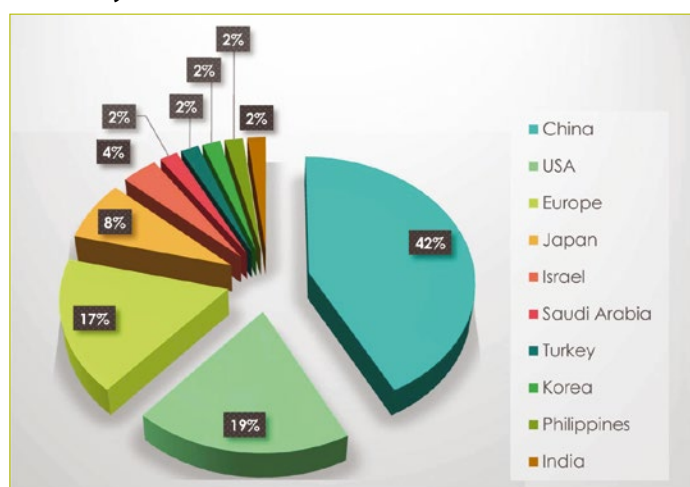
To explain it in even more detail, CRISPR comprise segments of DNA containing short, repetitive base sequences in a palindromic repeat (the sequence of nucleotides is the same in both directions). Each repetition is followed by short segments of spacer DNA from previous integration of foreign DNA from a virus or plasmid.

**Figure 1: Plant species studied in articles with agricultural applications between 2014-2017. (Source: Riccroch, Clairand & Harwood, 2017)**





**Figure 2: Number of articles studying the use of CRISPR systems in plant genome editing with agricultural applications according to country. (Source: Riccroch, Clairand & Harwood, 2017)**



### CRISPR in agriculture

To date this technology has been used in many industries, from human and animal health to crop breeding. It is a significant discovery that could change the way food is produced entirely. So how has this technology been utilised in the agricultural industry thus far?

Based on a recent literature review, the main goal of CRISPR systems in crops is to achieve improved yield performance, biofortification, biotic and abiotic stress tolerance, as well as plant quality enhancement.

With China being the leader in CRISPR research, rice is the most studied crop followed by maize, which is predominantly studied in the United States (US). Systems for genome editing in oilseeds such as soya beans and canola have also been reported. Other plants frequently studied are vegetables and industrial plants.

Most trait improvements relate to economic and agronomic challenges faced by producers, with pathogens and environmental conditions the leading threats to the industry. According to the literature review, applications relating to yield traits are by far the most studied for all crops, with biotic or abiotic stress tolerance the second most studied.

### Biotic stress tolerance

Biotic stress tolerance includes induced tolerance to viral, fungal and bacterial diseases, with a higher number of articles exploring plant tolerance to viral disease.

As for abiotic stress tolerance, the two main objectives are to achieve herbicide and natural environmental stress tolerance, which includes cold, salt, drought and nitrogen stress.

CRISPR could be used to improve the taste of crops such as tomatoes that have become flavourless due to breeding programmes

that focus more on yield than taste. It has even been applied to crops such as mushrooms to ensure a longer shelf life.

In addition, it could be applied to animal production – an application that might see health management and animal welfare improving. Studies have shown that CRISPR might aid in the breeding of polled dairy cows, which might reduce the need for dehorning.

The same technology could be used to produce disease-resistant animals. Recently, a team of American, Chinese and Korean researchers successfully cured a human embryo of a genetic disorder called hypertrophic cardiomyopathy. This application has great possibilities for human health.

### CRISPR in oilseeds

Unlike some of the agricultural crops discussed, oilseeds have not enjoyed as much research in terms of CRISPR applications. However, it has not been neglected entirely. A recent study has shown that CRISPR could improve crossbreeding of canola, an oilseed crop known to be difficult to breed.

The study indicated that CRISPR/Cas9 is an efficient tool for creating targeted genome modifications at one locus or multiple loci in the T0 generation, which are stable and inheritable by the progeny, thus making crossbreeding easier.

CRISPR has been used to improve the fat content of soya beans, for example. A team from the Centre for Genome

Engineering, within the Institute for Basic Research (IBS), succeeded in editing two genes that contribute to the fat content of soya bean oil using the new CRISPR-Cpf1 technology, an alternative to the more widely used gene editing tool CRISPR/Cas9.

IBS biologists designed CRISPR-Cpf1 to cut two of the FAD2 genes, which form part of the pathway that converts fat (oleic acid into polyunsaturated linoleic acid), in soya beans. Mutating these FAD2 genes increases the percentage of oleic acid in soya bean seeds, resulting in healthier oil.

CRISPR-Cpf1 did not cut non-targeted locations within the soya bean genome and the technique does not rely on the introduction of foreign DNA. The risk of leftover foreign DNA is therefore removed. CRISPR-Cpf1 could be used as a new tool to develop value-added crops, such as a new variety of soya beans with reduced unsaturated fat content.

### Role of regulations

Whether the application of CRISPR technology will truly benefit the agricultural industry depends largely on how it will be regulated. In March 2018 the United States Department of Agriculture (USDA) announced that it would no longer regulate genetically edited crops, including CRISPR techniques.

The USDA's decision applies only to crops from which some genes have been removed, or crops to which genes endemic to the species have been added. This editing, the regulatory agency says, is essentially an advanced form of accelerated selective breeding.

In the European Union (EU), however, a ruling made by the EU Court of Justice in July 2018 possibly deterred the development of plants created by CRISPR technology, which will need to go through the same lengthy approval process as traditional transgenic plants, although it does not involve transferring genes between organisms. 🌱

Source for tables used in this article:

Agnès Riccroch, Pauline Clairand, Wendy Harwood; *Use of CRISPR systems in plant genome editing: toward new opportunities in agriculture*, Emerging Topics in Life Sciences Nov 10, 2017. For other references, email the author at [ursula@plaasmedia.co.za](mailto:ursula@plaasmedia.co.za).

# How ammonium sulphate enhances weed control efficacy of herbicides

By Dr Charlie Reinhardt

**W**eed control with herbicides is generally accepted to be a rapid, relatively cheap and highly effective way of preventing unacceptable crop yield losses caused by weed interference. However, variable success with the use of herbicides is often encountered because of the unpredictability of climatic factors, the natural herbicide tolerance of certain weeds, and herbicide-resistant weeds.

In response, the agrochemical industry is constantly striving to find ways to increase the efficacy (effectiveness) of herbicides by, among others, reducing the variability (or lack of predictability) in herbicide product performance.

Not only is there the constant quest for novel chemistry in the form of new herbicide modes-of-action but also for the development of companion, non-herbicidal chemical compounds (adjuvants) that act as enhancers of herbicide biological activity; in other words, adjuvants can boost herbicidal effects on weeds, thus improving reliability of herbicide performance.

## Development of adjuvants

Given the slow-down (ongoing for longer than 20 years) in unique herbicides reaching the market, any extra tool for making chemical weed control more effective is of critical importance – development of adjuvants for herbicides is a case in point.

Simultaneous with the lag in novel herbicide modes-of-action reaching the market, herbicide resistance has escalated and presents huge challenges for effective weed control that must rely on the current 'old' range of modes-of-action. The herbicide market in the foreseeable future is, arguably, likely to benefit more from



*Leaf surfaces are typically not compatible with water, and the latter carries herbicide molecules to the plant in spray droplets. Thereafter, molecules must overcome several obstacles to penetrate into leaves, from where they are translocated to those plant parts where the site-of-action is located.*

*(Photograph by Dr Charlie Reinhardt)*

the entry of novel chemistry in the form of adjuvants than is the case for herbicides.

Enhanced herbicide activity with the aid of adjuvants is largely dependent on increased contact and compatibility of spray (water) droplets with the target organism (weed plants), and increased uptake of herbicides by weeds.

The use of ammonium sulphate as an adjuvant in herbicide application is common practice, because of its well-proven ability to improve herbicide efficacy or biological activity. In the broadest context the term 'adjuvant' refers to all those compounds added to spray mixtures with the intention to improve the biological activity (efficacy) of pesticides.

## Neutralising water-borne cations

Research has revealed that ammonium sulphate (AMS) has an important function

in the neutralisation or inactivation of cations such as  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Na}^+$ , etc., which are known to reduce glyphosate activity when the cation and herbicide molecule reacts chemically to produce biologically inactive molecules, for example Ca-glyphosate or Mg-glyphosate.

Calcium ( $\text{Ca}^{2+}$ ) and magnesium ( $\text{Mg}^{2+}$ ) cations typically occur in high concentration in so-called 'hard' water, which when used as carrier for spraying glyphosate can reduce the effectiveness of this herbicide and others that are susceptible to chemical reactions with cations.

The sulphate ( $\text{SO}_4$ ) component of ammonium sulphate ( $\text{NH}_4\text{SO}_4$ ) reacts with cations such as  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  present in water used as herbicide carrier in sprays to form inert (inactive)  $\text{CaSO}_4$  (calcium sulphate) and  $\text{MgSO}_4$  (magnesium sulphate), which does not interfere with herbicide activity.



Because cations such as  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  usually occur in variable concentration in all water sources, it is sound practice to use ammonium sulphate as adjuvant irrespective of the cation types and concentration of water used as herbicide carrier in spray mixtures. The ammonium cation ( $\text{NH}_4^+$ ) is not competitive with glyphosate and many scientific studies report its role in enhancing glyphosate efficacy.

### Enhancing herbicide entry

Plant-uptake and transfer of herbicides to the target site (e.g. a susceptible enzyme) within the plant system, where it exerts herbicidal (plant-killing or phytotoxic) activity, is a complex process and consists of several stages (Figure 1).

Herbicide mode-of-action comprises several processes, and all are equally important in determining effective weed control – ultimately, it is the critical (threshold) amount of herbicide that reaches the site-of-action which determines whether weeds are controlled effectively, i.e. killed, or not.

The biological activity of every herbicide is affected and can be manipulated in product formulation for the optimisation of herbicide action. Besides herbicide product formulation, adjuvants are instrumental for the optimisation of herbicide delivery, uptake by plants, and transfer in the plant system.

Most studies on the role of AMS in herbicide efficacy confirm its beneficial effect on the improvement of weed control. However, differences in AMS effect

have been reported among glyphosate formulations and weed species.

In South Africa, Dr Brian de Villiers of Villa Crop Protection has conducted significant research on the effects of formulation and adjuvants on glyphosate activity. In the case of glyphosate, AMS not only protects the integrity of this herbicide in the spray tank but also increases its uptake and translocation to its site-of-action (the EPSPS enzyme in the case of glyphosate).

### Increase droplet drying time

AMS is a member of the group of adjuvants that increase spray droplet drying time on leaf surfaces. A substance that increases the drying time of a spray droplet is called a humectant. Humectants are typically water-soluble compounds that resist drying even after the water component of droplets has evaporated. Increased drying time is achieved by the humectant drawing water from the atmosphere.

Because uptake into leaves can occur only when the herbicide is in solution, slowing the rate at which droplets dry will allow more time for uptake (absorption). Theoretically, a humectant should improve herbicide performance under hot, dry conditions. However, herbicide performance rarely increases with the addition of a spray adjuvant if weeds are under severe moisture stress.

The ammonium ( $\text{NH}_4^+$ ) ion reportedly enhances the movement or transfer of certain herbicides from one cell to another in plant tissue. The transfer

mechanism involves pH changes and pH differences in different parts of cells, and pH-regulated electric charge that is induced on herbicide molecules.

Gronwald *et al.* (1993) demonstrated that ammonium is taken up (absorbed) by leaves and induces acidification of cell walls (lowered to a pH of approximately 4.5 to 5), while the cytoplasm is at pH 7. They found that imazethapyr herbicide molecules are negatively charged at pH 7 in the cytoplasm and that they undergo protonation in the cell wall, which is relatively acidic at about pH 5.

### Neutral molecule

During protonation, protons ( $\text{H}^+$ ) are attracted to the negative charge on the imazethapyr molecule, thus rendering the molecule neutral (carries no electric charge). It is only in this state (neutral) that the imazethapyr molecules can move through the plasmalemma (cell membrane), which acts like a filter to prevent movement of foreign substances through the plant system.

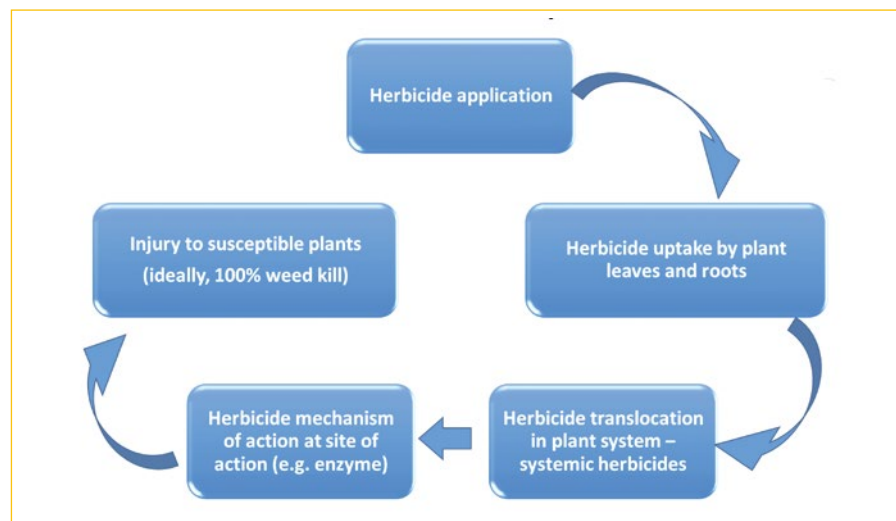
Once in the cytoplasm (pH 7) neutral imazethapyr molecules lose protons ( $\text{H}^+$ ) and negative charge is restored. This process is repeated from cell to cell; hence, molecules of a systemic, weak-acid herbicide such as imazethapyr can move between plant cells on their way to the site-of-action which, in this case, is the enzyme acetolactate synthase (ALS).

The same mechanism is probably also involved in the transfer of other systemic, weak-acid herbicides such as glyphosate. It is generally accepted that AMS can increase weed control efficacy of both imazethapyr and glyphosate. 🌱

Cautionary note: Only AMS products that are registered for use with herbicides must be considered and not fertiliser grade AMS, because impurities in the latter could antagonise herbicide activity.

For more information and references, contact Dr Charlie Reinhardt on 083 442 3427 or email [dr.charlie.reinhardt@gmail.com](mailto:dr.charlie.reinhardt@gmail.com). Dr Reinhardt is dean of the Villa Academy, and extraordinary professor in the Department of Agronomy, Stellenbosch University.

**Figure 1: The processes of herbicide mode-of-action.**



# Remedial measures technique shows the way in soya

By Dr Steven A Oosthuysen, HortResearch SA

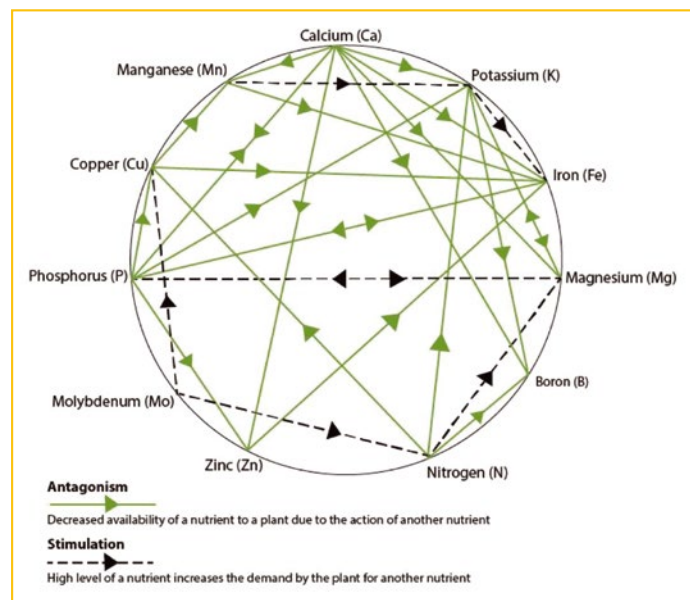
**T**he remedial measures technique is an analytical 'numbers' procedure enabling the analyst to determine factors of a multiple nature affecting an outcome. Such an outcome is bean yield – as is evident in the case of the Protein Research Foundation's exercise carried out on soya bean plants grown at two locations in South Africa.

The multiple factors assessed are those relating to soil fertility and favourability for growth and productivity. The procedure is entirely empirical, having no reliance on assumption.

## Complex interactions

Interactions between plant nutrients in the soil affecting root uptake are complex. Mulder tried to indicate these in his chart (Figure 1). The implication is that prediction of uptake based on application quantities is an inaccurate science.

**Figure 1: Mulder's chart indicating nutrient interactions in the soil as they promote or retard root uptake.**



The remedial measures technique, in relating yield metrics to nutrient levels and other soil variables, provides direct information of applications and circumstances that will specifically, if simultaneously altered, affect yield.

The technique is being demonstrated on irrigated soya growing in a clay soil near Rustenburg (Ferdie Meyer) and on dryland soya growing in sand near Bothaville (Jan Botma). At each site 20 plant-clumps (eight to ten plants), well distributed in the trial area, were uplifted with soil attached to the roots.

The soil adhering to the roots of each plant was analysed comprehensively (20 analyses), as

well as the plant in terms of bean yield and dry matter content. Soil pH, nutrient content (P, K, Na, Ca, Mg, Fe, Mn, Cu, Zn, and B in mg/kg), cation exchange capacity (cmol (+)/kg), and bulk density (kg/m<sup>3</sup>) quantified from each sample were evaluated with regard to component influence on plant performance.

The analytical procedure makes use of a multivariate statistical algorithm identifying factors of significance as determinants of plant performance at each growth site. The results indicate goals to be achieved – those associated with best performance. The plant samples that were taken comprised outstanding, moderate and poor performers.

## Increasing bean yield

In Rustenburg, where the soil of the area under consideration naturally exhibit a positive imbalance of magnesium, bean yield bore a highly significant relationship with soil potassium, soil magnesium and cation exchange capacity. The component potassium relationship was positive whereas that of magnesium was negative (Figure 2 and 3).

Cation exchange capacity's component effect was positive. Increasing soil K to

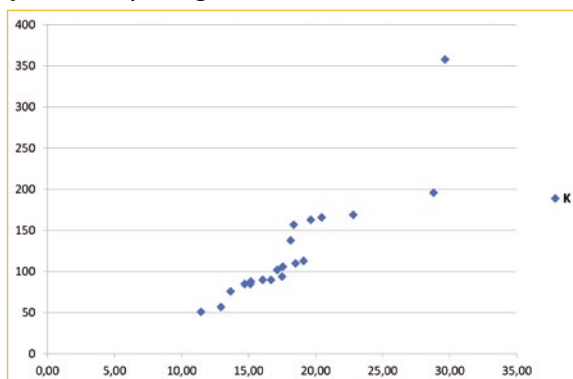




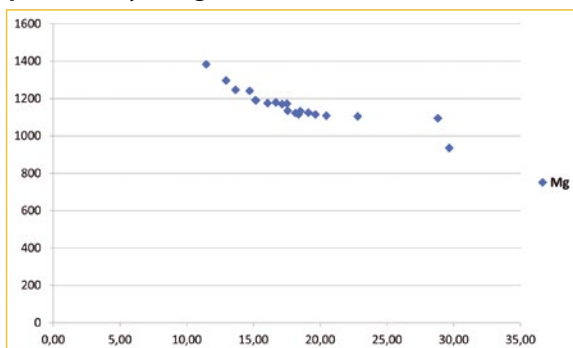
200ppm for the following season is an attainable goal, expected to generally increase bean yield. Practically, reducing soil Mg and increasing soil CEC are impractical to achieve in the short term. Mg application should be excluded, and adjustments of the other nutrients (N, P, Ca, Cu, Fe, Mn, Zn, or B) should be made to cater for expected crop removal of these nutrients.

At Bothaville, where the soil is almost 100% sand, bean yield bore a highly significant relationship with cation exchange capacity and Zn concentration. The component Zn relationship was positive as was the cation exchange capacity relationship. Plant performance

**Figure 2: Soil K concentration (Y axis) as it related to plant bean yield (g).**



**Figure 3: Soil Mg concentration (Y axis) as it related to plant bean yield (g).**



was markedly better where nutrient retention was slightly greater.

The analysis also indicated a yield response to Zn. In view of it not being possible to alter cation exchange capacity in a season, it was recommended that fertiliser catering for expected crop removal be applied in a number of applications – as many as four – from the time of planting.

Fortnightly applications may be appropriate, as well as the use of controlled release or reduced-release granular fertiliser. Spray application of zinc nitrate when the plants have leafed-out somewhat was also recommended.

The benefits of these alterations are to be assessed during 2019 a number of weeks prior to harvest. The analysis procedure is to be repeated at each site to determine further adjustments to continue bean yield increases. The results of these endeavours are to be communicated in our next article. 🌱

For more information, visit  
[www.hortresearchsa.co.za](http://www.hortresearchsa.co.za).

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# Biofertilisers – the brown revolution?

By Dr Hugo Opperman, plant physiologist, Omnia Nutriology

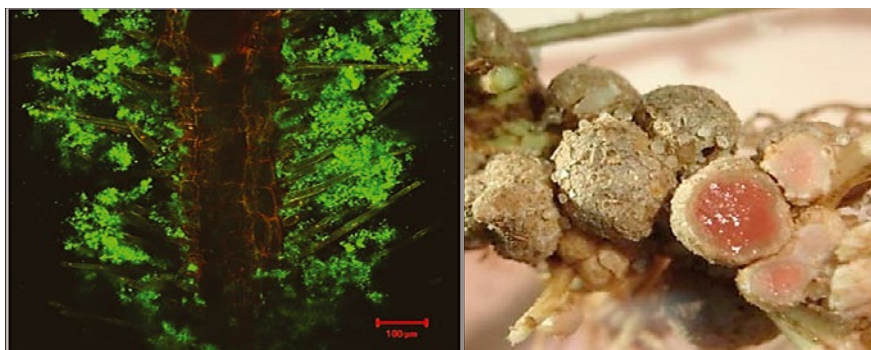
During the late 1950s there was tremendous improvement in the agro-technology sector which included better crop varieties, the production of chemically pure fertiliser sources and mechanisation. This phenomenon was termed the 'green revolution', which led to a great increase in crop production efficacy and crop yields.

A growing world population and a decrease in arable agricultural land have placed sharp emphasis on the need for another agricultural revolution, to match the impact the green revolution had on crop production.

The current agricultural practice of high fertiliser inputs is no longer sustainable to meet the needs of the ever-growing global population. High chemical fertiliser inputs have also been shown to have a detrimental effect on the environment, especially the eutrophication of fresh water sources.

## A more holistic view

Scientific advances have made it possible to study plant physiology and the inherent symbiotic interaction of plants with their environment, which shifted the focus away from



*Bacillus subtilis* (green) colonising plant roots, left, and a cross-section of a healthy soya bean root nodule infected with *Bradyrhizobium japonicum*, right.

the nutrient needs of only crops, to a more holistic view that is fast becoming the new agricultural norm (Figure 1).

This new approach has opened the door to relatively new, more sustainable agricultural practices in which the importance of soil biology plays a vital role. The root microbiome is the dynamic community of microorganisms associated with plant roots.

Because they are rich in a variety of carbon compounds (root exudates), plant roots provide unique environments for a diverse assemblage of soil microorganisms, including bacteria, fungi and archaea. With the focus on soil ecology, a

new class of fertilisers, known as biofertilisers, has been established.

A biofertiliser can be defined as a substance that contains living microorganisms which, when applied to seeds, plant surfaces or soil, colonise the rhizosphere or plant interior, thereby promoting plant growth.

## Diverse effect on plant growth

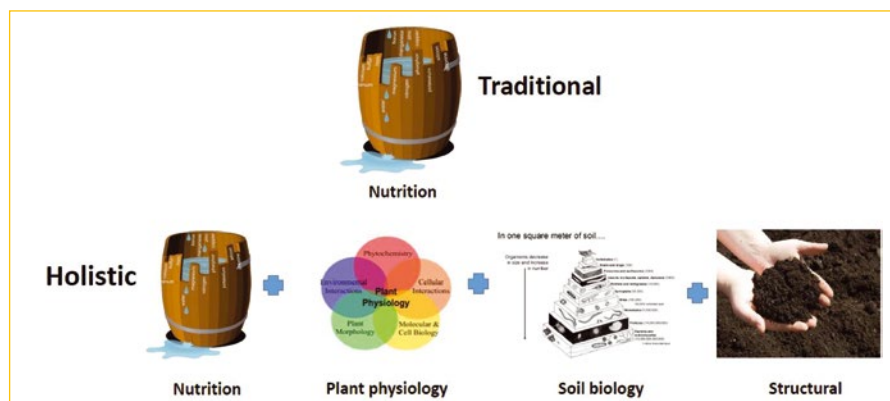
Reported effects by microorganisms on plant growth is very diverse and include increased root growth, increased chlorophyll content, increased nutrient uptake, improved photosynthetic efficiency, improved abiotic (drought, cold, heat, etc.) and biotic stress (pathogen) tolerance, as well as an increase in yield and/or fruit quality.

Four main modes of action have been identified:

- Biofertilisation.
- Phytostimulation.
- Biocontrol.
- Induced systemic resistance.

These living microorganisms can be bacterial or fungal in nature. There are two main types of beneficial fungal species used in agriculture today, *Trichoderma* and *Mycorrhiza*. They have very similar modes of action. Several bacterial

**Figure 1: Traditional Liebig's law of minimum vs an increasing holistic view of crop interactions.**







Roots of maize plants grown in a saline and control medium. Left = non-inoculated plant grown in saline medium. Centre = control plant in non-saline medium. Right = plant grown in saline medium but inoculated with a *Bacillus amyloliquefaciens* strain.

genera have also been shown to have a positive effect on plant growth. These include several *Bacillus*, *Pseudomonas* and *Gluconacetobacter* species.

These beneficial bacteria are referred to as plant growth promoting rhizobacteria (PGPR). Although the morphology and means of plant infection differ between beneficial fungi and PGPR, their mode of action in terms of growth stimulation and biocontrol is strikingly similar.

The most common biofertiliser in agriculture is legume (soya beans, mung beans, etc.) inoculation with the nitrogen fixing rhizobacteria, species *Bradyrhizobium japonicum*. The rhizobium bacteria infect plant roots and cause structures on the roots known as nodules, which can absorb atmospheric nitrogen ( $N_2$ ) and convert it into the plant available nitrogen, ammonia ( $NH_4^+$ ).

### Secondary metabolites

Microorganisms can also liberate mineralised plant nutrients (plant unavailable) through the production of large amounts of organic acids, enzymes and chelating agents known as siderophores, which convert mineralised nutrients into a plant available (water soluble) form. Liberation of bound soil phosphate and potassium into plant available forms by microorganisms is commonly reported, especially by

*pseudomonas* and *bacillus* species.

Beneficial microbes produce a host of secondary metabolites (SMs), including plant hormone-like substances. Some SMs, known as phytohormones, can stimulate plant development, especially at the root level (i.e. formation of more lateral roots). This is achieved by activating an auxin-dependent mechanism and/or producing the auxin indole-3-acetic acid (IAA) or auxin analogues such as koniginins and trichocaranes. This process is known as phytostimulation.

Some potent antibiotic SMs such as hydroxy-lactones, isocyanates and harzianic acid have also been isolated from some microbe species. These compounds can act as biocontrol agents, causing a direct toxic effect on pathogens, without any negative effect on plant growth.

Starving pathogens of critical nutrients such as iron (Fe), by binding available Fe through the production of strong chelating agents called siderophores, is also an efficient strategy employed by several microorganisms to out-compete pathogens in the rhizosphere. Several microorganisms produce a host of enzymes such as cellulase and chitinase, which can cause cell wall degradation and death of pathogens.

### Defensive mechanisms

Some enzymes (such as chitinase) can stimulate an innate defensive mechanism in plants, known as induced systemic resistance (ISR). Induced resistance is a physiological 'state of enhanced defensive capacity' elicited by specific environmental stimuli, whereby the plant's innate defences are potentiated against subsequent biotic challenges.

This enhanced state of resistance is effective against a broad range of pathogens and even insect herbivores. During ISR, the plant hormones jasmonic acid and ethylene act as signalling molecules that upregulate plant defence systems. Jasmonic acid and ethylene can also be released as volatile analogues, which can 'warn' surrounding plants of an impending pathogen.

Some microbial product field

studies have reported mixed results in terms of efficacy, which is due to the effectiveness of microbial survival and the ability to colonise the rhizosphere. The rhizosphere is a complex habitat where plant and microbial populations interact with each other and is affected by many biotic and abiotic factors. The success of bacteria to enhance plant growth depends on its potential to colonise the plant root.

Microbes use different strategies for their survival in the environment. The success of these strategies depends upon their ability to adapt and outcompete other microorganisms in nutrient limited conditions, efficient utilisation of root exudates, their interaction with plants and their ability to form spores when adverse environmental conditions persist.

### Correct biological product

Microbes have different strategies to colonise plant roots. Fungi tend to penetrate the root surface, thereby forming a physical bond with the host plant's root system. Some bacterial species produce sugar-like exopolysaccharides that help them adhere to plant roots, giving them a competitive advantage. Different microbes are more adapted to a given set of environmental conditions, highlighting the need to choose the correct biological product to suit the conditions.

The use of multi-strain products over single-strain products is recommended, because this increases the chance of at least one strain effectively colonising the rhizosphere. When using microbial products, the timing and method of application of the product is also crucial to ensure effective colonisation.

Products can be applied on the seed, in the furrow, as well as with irrigation and are available in liquid or dry powder spore form. Care must be taken not to directly expose or co-apply these products with harsh chemicals (nutrients or crop protection products), which could lower cell count and viability. 🌱

For more information, email the author at [hugo@mbfi.co.za](mailto:hugo@mbfi.co.za).

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# Guidelines for the disposal of empty plastic pesticide containers

By Ursula Human

CropLife South Africa (CLSA) recently made the August 2018 guidelines for the responsible disposal of empty plastic pesticide containers available on its website, [www.croplife.co.za](http://www.croplife.co.za).

According to these guidelines, empty plastic pesticide containers must be rinsed three times in succession with clean water equal to one quarter of

the container's volume (this is called triple rinsing) and rinse water must be decanted into the spray bowser.

Empty containers may not be burned or buried on the farm, sold or given away as containers for any other commodities. They can, however, be recycled if they have been triple rinsed. CLSA has approved several service providers that can dispose of such containers; the list of

approved service providers is available on [www.croplife.co.za](http://www.croplife.co.za).

## Guidelines for disposal

- Triple rinsed containers must be dried out and preferably cut into quarters to reduce transport volumes.
- Farmers must use the services of CLSA approved collectors/recyclers (see list on the CLSA website) to dispose of empty, triple rinsed containers. It is the duty of the farmer to contact the collector or recycler of choice and arrange for the disposal of these containers.
- Triple rinsed, dried out, empty containers are not considered to be hazardous waste and may be transported by normal vehicles.
- Containers that have any pesticide residues may not be transported by normal means and may not be collected or recycled. Such containers are treated as hazardous waste.
- Empty, triple rinsed containers may not be stored for longer than three months at any given site, unless that site is registered as a waste collection and storage site. It is therefore imperative that farmers dispose of their empty containers at least once every three months.
- Collectors/recyclers are not obligated to collect empty triple rinsed containers on farms or to pay any fees for such containers – it is up to farmers to negotiate any specific terms with the respective service provider.
- Farmers must request a CLSA certificate of adequate disposal from the CLSA approved collector or recycler once containers have been checked and handed over.

**Triple rinse all empty plastic pesticide containers!**  
**Spoel alle leë plastiek plaagdoderhouers drie keer!**

Decant last pesticide by turning container upside down over spray tank for 30 secs  
Giet laaste plaagdoder uit houer oor spuitenk vir 30 sekondes

**FOLLOW THESE STEPS  
VOLG DIE STAPPE  
X 3**

**1**  
Fill with one quarter clean water  
Vul met 'n kwart skoon water

**2**  
Shake 30 seconds  
Skud 30 sekondes

**3**  
Decant into spray tank for 30 seconds  
Giet oor in spuitenk vir 30 sekondes

Do these steps three times!!  
Doen die stappe drie keer!!

Always wear protective clothing  
Dra altyd beskermende klere

Puncture the rinsed container to render it useless and send to a CLSA approved recycler  
Kap gate in die gespoelde houer om dit onbruikbaar te maak en stuur na 'n CLSA goedgekeurde verwerker

[www.croplife.co.za](http://www.croplife.co.za)  
087-980-5163  
[info@croplife.co.za](mailto:info@croplife.co.za)

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For more information, contact  
Dr Gerhard Verdoorn at  
[neshier@tiscali.co.za](mailto:neshier@tiscali.co.za).





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# Revolutionising agriculture through canola

**B**ased in Swellendam in the Western Cape, Southern Oil is the local leader in canola agriculture and canola oil production, as well as the largest canola crusher in Africa. From humble beginnings in 1993, the company has revolutionised agriculture in the province with the aim of creating jobs and providing farmers with an alternate income stream in the ever-growing canola market.

## Farming together for the future

One of Southern Oil's greatest assets is its relationship with canola farmers. Izane Crous and Zander Spammer, Southern Oil's agricultural experts, offer practical advice and solutions for canola producers who work with Southern Oil and take great pride in assisting farmers to develop crops through sustainable farming practices.

Canola is an ideal inclusion in crop rotation and can provide an additional channel of revenue while also yielding

benefits for soil health. Southern Oil's experts are on hand to guide producers through canola growth, maintenance and harvest processes and their success is evident.

Despite the Western Cape battling drought conditions, this year's harvest can possibly yield 90 000 tons of canola seed, thanks to the conservation agriculture practices implemented under Izane and Zander's guidance.

## Canola on the rise

The great news for local producers is that the South African middle class is fuelling the growth in popularity of canola oil. Because it has the lowest saturated fat of all cooking oils, consumers are eagerly switching to canola oil as their cooking oil of choice, which creates a need for more canola crops.

Southern Oil has partnered with over 500 canola producers and procures all the locally grown canola seed, guaranteeing a good return on investment for local farmers. Demand for seed crushing, extraction and

refining continues to grow and Southern Oil already has plans underway to meet this demand by expanding its crushing and refining capacity and increasing its supply of highest quality services.

## Exciting prospects

At the Swellendam plant, approximately 110 000 tons of canola seed are crushed annually, and the plant produces 45 000 tons of crude canola oil per year. The new product development division is able to create cooking oils and salad dressings to client specifications and the on-site bottling facility allows Southern Oil to also offer specific product packaging. With an exciting few years ahead for this continually growing business, the future looks blooming brilliant for Southern Oil – your canola company.

For more information on Southern Oil and its services to the agriculture and food manufacturing industries, visit [www.soill.co.za](http://www.soill.co.za).

# South African soya beans in abundance!

By Dr Dirk Strydom, Grain SA

According to the Crop Estimates Committee's (CEC) final estimate of the year, South Africa produced a record soya bean crop of 1,55 million tons. The ten-year average for soya bean production in South Africa is almost half of this at 758 487 tons.

Almost five years ago the soya bean industry and various government departments developed a strategy to further develop and expand the local soya bean industry. The increase in local processing capacity coincided with an increase in production. Now the local soya bean industry is yet again at a stage where new markets are needed due to an oversupply.

According to the National Agricultural Marketing Council's (NAMC) supply and demand estimate, an ending stock of more than 600 000 tons is expected at the end of the 2018/19 marketing season. This represents six months of available stock for the new season.

In terms of the planting intentions published by the CEC at the end of October, expectations are that soya bean hectares will increase. The estimate is currently 851 800 hectares, which represents a year-on-year increase of 8,2%. This means that according to a three-year average yield and consumption, South Africa could have a stock to usage ratio of 82% at the end of the 2019/20 marketing season.

Bear in mind though that these are intentions and that weather conditions can still affect the actual planting figures (Table 1).

**Table 1: A sensitivity measure of possible scenarios with yield and hectare variance.**

|                |      | Area planted (ha) |         |         |               |         |         |           |
|----------------|------|-------------------|---------|---------|---------------|---------|---------|-----------|
|                |      | -20%              | -15%    | -10%    | CEC Intention | +10%    | +15%    | +20%      |
|                |      | 681 440           | 724 030 | 766 620 | 851 800       | 936 980 | 979 570 | 1 022 160 |
| Yield (ton/ha) | 1,40 | 31%               | 36%     | 40%     | 50%           | 60%     | 65%     | 70%       |
|                | 1,55 | 39%               | 44%     | 50%     | 61%           | 72%     | 77%     | 82%       |
|                | 1,70 | 47%               | 53%     | 59%     | 71%           | 83%     | 89%     | 95%       |
|                | 1,85 | 56%               | 62%     | 69%     | 82%           | 95%     | 101%    | 107%      |
|                | 2,00 | 64%               | 71%     | 78%     | 92%           | 106%    | 113%    | 120%      |
|                | 2,15 | 73%               | 80%     | 88%     | 103%          | 118%    | 125%    | 133%      |
|                | 2,30 | 81%               | 89%     | 97%     | 113%          | 129%    | 137%    | 145%      |
|                | 2,45 | 89%               | 98%     | 106%    | 124%          | 141%    | 149%    | 158%      |

On a longer-term basis it is expected that more soya beans will be produced in South Africa. The new breeding and technology levy on soya beans will attract new technology and hopes are that this will increase yields.

As illustrated in the five-year and ten-year yield averages in Figure 1, South Africa did not experience substantial improvements in yield. Given the increase in costs and the price cost squeeze, increases in yield are important for maintaining sustainable production. However, these

increases in production need to be facilitated with an increase in demand.

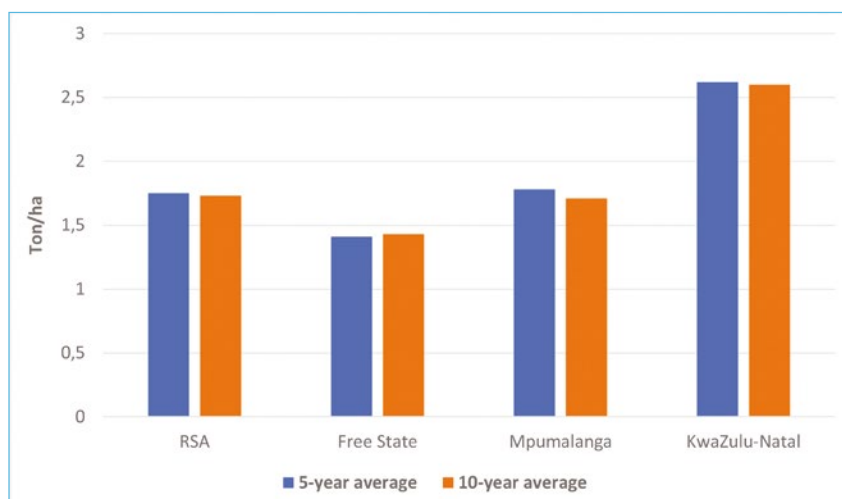
## New markets and local demand

It is clear that new markets are needed for South Africa in order to sustain production going forward. Demand for soya beans must increase at two different levels in order to have a large impact: Exports are needed in a bid to decrease stock levels, and growth in local soya bean processing is needed.

Before the strategy to increase

processing capacity within South Africa was implemented, considerable volumes – 120 000 ton on average – were exported between 2009 and 2013. However, these markets need to be regained yet again and new markets need to be developed. The trade environment for soya beans is currently highly competitive due to the trade war between the US and China.

**Figure 1: Five- and ten-year soya bean yield averages.**





Many opportunities are available for South Africa, given our position within BRICS and the geographical position towards the east. Yet these exports will only become a reality if the necessary export regulations are in place, the quality of our soya beans is acceptable, and the global market price is competitive.

The global soya bean trade market has changed substantially over the past six months. It is clear from the import-export parity graph that the Safex prices are below South American prices, which is currently predominantly a Chinese market. However, the Safex prices are above the US export parity prices, which is servicing the rest of the world (Figure 2).

In terms of the local demand for soya beans, some processors had breakages this season, which meant that crushing capacity could not be utilised at maximum levels. However, there are also still large oilcake imports to consider. According to the South African Revenue Service, 208 000 tons of oilcake were imported from April until the end of August, amounting to R1 billion (five months of the marketing season).

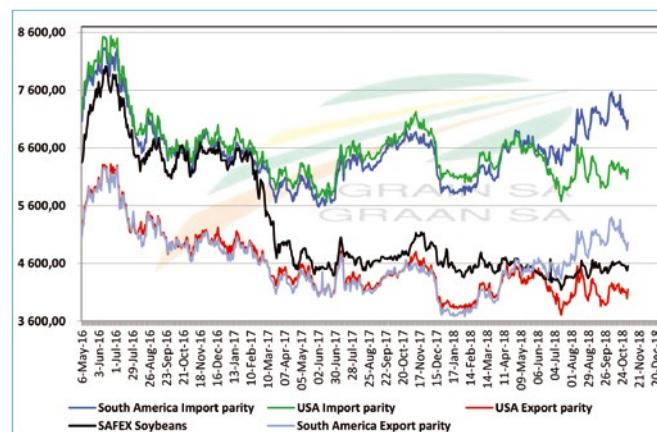
Last year's oilcake imports totalled 519 071 tons with a value of R2,1 billion for the marketing year. If these imports can be replaced with local soya bean crushing, it means an additional market of approximately 650 000 tons.

In terms of the current South African economic and National Development Plan's (NDP) vision of creating jobs through agro-processing, soya beans are ideally positioned to accomplish these dreams – creating local high value produce and creating jobs with export markets. There is a large global demand for feed and more specifically oilcake.

### International market

The US experienced challenges with its soya bean harvesting at the beginning of November, due to the adverse weather conditions over large parts of the country. Although the delay in harvesting led

**Figure 2: Soya bean parity prices. (Source: Grain SA)**



**Table 2: Most important oilseed products (US\$/ton). (Source: Oil World and Reserve Bank)**

| Product                       | 1 Nov 2018 | Oct 2017 | % change |
|-------------------------------|------------|----------|----------|
| Soya beans (US CIF Rotterdam) | 359        | 368      | -2%      |
| Soya beans (Brazil)           | 404        | 385      | 5%       |
| Sunflower seed (EU)           | 377        | 375      | 1%       |
| Groundnuts (US 40/50)         | 1 250      | 1 315    | -5%      |
| Palm oil (Malaysia)           | 520        | 539      | -4%      |
| Soya bean oil (US)            | 674        | 691      | -2%      |
| Sunflower oil (Arg)           | 665        | 673      | -1%      |
| Soya meal (Arg)               | 362        | 375      | -3%      |
| Fishmeal (Peru)               | 1 380      | 1 380    | 0%       |
| Rand/\$                       | 13,7       | 14,19    | -3%      |

to yield losses, the US production will still set a new record this season.

US exports are significantly lower than usual since the loss of China's import market for US soya beans. Some of the last US exports that were supposed to be shipped to China were sold to other countries. The large American soya bean stocks along with lower exports are keeping US soya bean prices under pressure.

Soya bean plantings are progressing well in Brazil and the first stock of the new season will be available in the market earlier than usual. This is beneficial because China is buying large volumes of Brazilian soya beans and there are still good premiums available in the Brazilian market.

### Ukraine sunflower production

In the Ukraine, the sunflower seed harvesting process stood at 96% completed by the first week of November. Production for the season looks good and the average yield is 14% higher than the previous season.

In Russia, the average yield of sunflower seed is 3% higher than the previous season.

Australian canola exports were significantly lower than the potential in September and the final figures for the month closed at a four-month low. Total Australian canola exports for the season were lower and this will cause the canola stocks in Australia to be unusually high at the end of the year.

Canadian canola prices are still trading at a discount against European canola, with Canadian prices mainly under pressure due to the large stock levels available as well as an overflow effect from low US soya bean prices.

In the US, the November production progress report showed that 66% of American groundnuts had already been harvested. This is lower than the five-year average rate of 70% completed at that time of year and lower than last season's 72% completed at the same time during the season.

In terms of price movement, most oilseeds and products decreased year-on-year, except for Brazil that is currently capitalising on the new Chinese market (Table 2).

### In summary

South African soya beans need to source and unlock new local and international markets. The high estimated supply can put additional price pressure on soya bean prices. Internationally there is ample opportunity for trade due to the current trade war; however, this is accompanied by growing competition.

It is important to evaluate the new negotiations between China and the US, since this will have a large impact on global prices. The exchange rate is still very volatile and impacts export parity levels. The exchange rate is still very difficult to forecast with all the current uncertainties within the economic and political conditions of the country. 🌱

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# Electricity and energy: What does the future hold?

By DeVilliers Botha, COO, Solareff

**D**rought, state capture, land reform, Eskom – these are the most topical conversations of 2018. A good friend once said: “If you worry about things you cannot change, you’ll grow old before you’re due.” The rhetoric almost sounds like a lesser known Don Williams song.

As for the first three there is very little that we as individuals can do. However, when it comes to supplying electricity, there might be some solutions.

Here are a few aspects to consider: Our ancestors farmed much smaller tracts of land than what we regard today as commercial units, and yet they still made a good living. Where has the commercial wisdom of the previous generations gone?

Perhaps we have all been subjects of the ‘frog in the boiling pot’ effect. We have become accustomed to genetically modified (GM) seed, effective implements, powerful bakkies, private schooling and electricity at the flick of a switch. And when we experience load shedding, we use four and five letter words to express our frustration.

## Eskom as a supplier

In most of the vast areas where seed is grown, Eskom supplies electricity by means of overhead lines – also referred to as the grid. These lines are usually part of their distribution network that supply 11kV or 22kV – also termed MV (medium voltage) lines.

Eskom installs a transformer close to the points where end-users utilise the electricity. The transformer reduces the voltage of the line from MV

to LV (low voltage), which is then supplied and metered by Eskom to us at 400V.

Eskom charges end-users for each point of supply through an account that contains various service fees, network charges, supply charges and redundancy charges (to name but a few). These are all fixed charges, which means they are charged to our account whether we use electricity or not. These charges often range between R1 925 and R4 670 per point of supply.

Only once we have paid these charges, we are able to start using electricity – for which we are again charged through our consumption measured in kWh (charges will depend on the tariff we are on). A fixed tariff applies throughout the time of day – these are termed land rate, home power, etc.

A time of use (TOU) tariff is one that fluctuates throughout the day, according to the average demand of the network. It is divided into peak, standard and off-peak times with peak being the most expensive and off-peak the cheapest.



*Equipment supplying uninterrupted power to a farmstead that was installed after the farmer found the quote from Eskom excessive.*

The principle applicable when purchasing electricity from the grid, is that as long as you pay, you will receive supply, a scenario that was at the order of the day before load shedding became an ongoing reality in 2008. Since then, we have grown accustomed to paying a monthly amount as part of our operational expenses (OPEX) for the electricity supplied to our properties, also termed pay-as-you-go or as you use the resource.

This is very similar to the way contract harvesters are paid (pay-as-you-go) to harvest our fields, due to the cost of ownership of the equipment, which can cost several millions.



*Solar panels on the roof of one of the buildings at Graham Beck Wines.*

## Alternative energy

While it may make financial sense to use contract harvesters for a seasonal asset, it need not be the case for your electricity supply.

When the supply of electricity from an off-grid Solar PV system, which would set you back R450 000 for a 15-year supply (and yes, that’s how long the lithium ion batteries are designed to last), you’d



think again about the money you pay in the form of 'fixed charges' to Eskom.

But can it really be done? The answer is yes, but only if you work with a reputable solar PV provider. The correct supplier will provide you with a properly engineered solution specifically designed to meet your requirements. You may initially pay more for the professional solution, but you can rest assured that your expected benefits will be guaranteed. This is often not the case with so-called DIY suppliers.

### Case studies

**Off-grid – Heidelberg (GP):** In Heidelberg (Gauteng), Mr Van Driel found the quote from Eskom to supply his farmstead via a new distribution line excessive. Instead he opted to install a 9,75kWp solar PV system, coupled to a 10kVA inverter and a 15,36kWh battery. He also installed a 13kVA diesel generator to supply charge to the batteries during adverse weather. By investing in this solution Mr Van Driel enjoys an uninterrupted power supply, although he has never had any grid supply to his farmstead.

**Grid-integrated – Mossel Bay:** Mr Botha from Mossel Bay had an existing grid supply to his house from the local municipality, but felt the consumption cost of R1,82 per kWh was excessive. He installed a system similar to Mr Van Driel, but with supply from the grid to maintain his home on rainy days (instead of the generator used in case one).

Look at the generation profiles for October 2018 (Figure 1). The red sections on the bar graph indicate the consumption from the grid, the blue from the battery and the yellow from the Solar PV. The days with a larger red section were cloudy days.

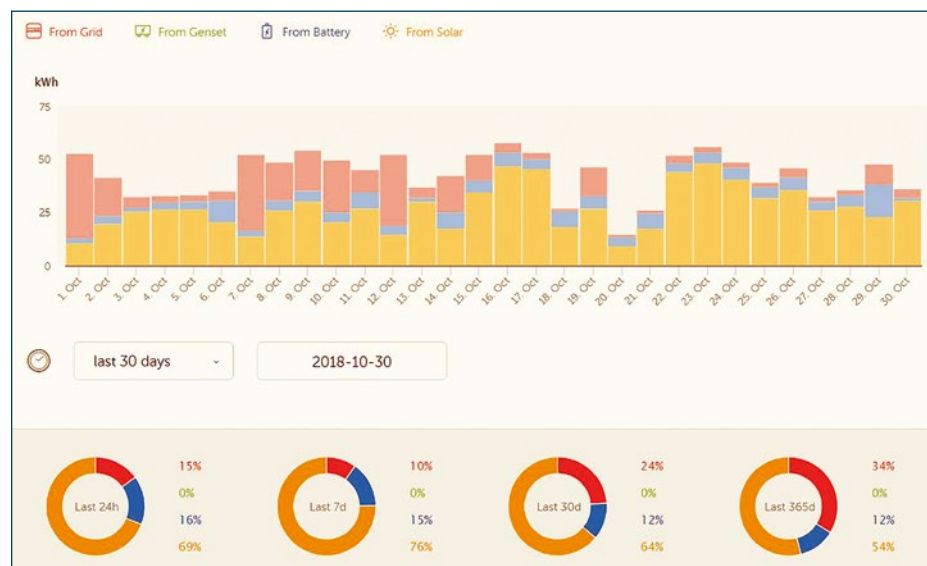
**Grid-integrated – Robertson:** Graham Beck Wines opted for a grid-tied solution for their winery, which was installed during the latter half of 2016. Apart from the financial saving of using less power from the Langeberg municipality, this solar solution has established their brand as a green producer of MCC for their local and international markets.

All three the scenarios are termed small-scale embedded generation or SSEG.

### Regulatory matters

Since late 2017 there has been several changes to the regulatory environment for legally installing or connecting alternative energy generation facilities. The most

**Figure 1: Generation profiles for October 2018.**



pertinent reference documents are Schedule II to the *Electricity Regulation Act, 2006* (Act 4 of 2006, i.e. ERA), the Integrated Resource Plan (IRP) and Nersa rules.

The aspect of licencing changed to the effect that any generation facility in excess of 1MW requires a licence. Given the traditional dryland farming operation of the oilseed industry and the scale on which extraction and pressing is done, this burden would not easily befall the industry (given traditional oilseed farming electricity requirements). However, it is something to keep in mind should you consider expanding to that scale.

In accordance with the ERA Act, all generation facilities must be registered with Nersa. Nersa is still in the process of developing these rules for registration, and at the time of writing we are still awaiting the imminent release of the updated IRP, which would direct government's plans for the future generation of electricity.

Earlier this year, some public benefit organisations (PBOs) flooded social media with the comment: "Nersa will tax your solar panel". With respect, these PBOs used an incorrect interpretation of the ERA Act, whereby Nersa is funded from licenced generation facilities, to create public mayhem. There is no need to worry about your SSEG system being arbitrarily taxed – as long as you have complied with regulation and registration from the start.

In addition, you will need to apply to and obtain consent (for the types of systems

in scenarios one and two) from your electricity supply utility, either Eskom or the municipality. Most utilities have processes and policies in place for this. Once you have successfully navigated these hurdles, you will have years and years of independent and cost-effective electricity supply.

### Summary

Although we like to criticise Eskom, we should recognise and respect the fact that they have kept the lights on in South Africa for many years. The increased costs of operation and the rise of cheaper, efficient alternatives have driven them to rethink their business of generating from coal resources, but it is difficult to turn such a large ship!

Solar PV has become a viable alternative for farmers due to ever increasing utility tariffs and the reduction in costs of alternative energy technology.

The question is simply this: Does it make financial sense for your farming operation? If not, wait until the utility tariff increases further and once it does, it ultimately becomes a no-brainer. Add a financing solution to the offering (supported by most leading financial institutions) and can you simply divert your former Eskom expense to the repayment of the loan for a financially viable solution.

But most importantly, find a reputable supplier of these products and services with a proven track record. 🌞

For more information, phone DeVilliers Botha on 082 924 7342.

# The role of peanuts in the prevention of coronary heart disease

By Penny M Kris-Etherton, Frank B Hu, Emilio Ros, and Joan Sabate

**E**pidemiological and clinical trial evidence has demonstrated consistent benefits of nut and peanut consumption on coronary heart disease (CHD) risk and associated risk factors. The epidemiological studies have reported various endpoints, including fatal CHD, total CHD death, total CHD, and nonfatal myocardial infarction.

A pooled analysis of four US epidemiological studies showed that subjects in the highest intake group for nut consumption had a 35% reduced risk of CHD incidence. The reduction in total CHD death was primarily due to a decrease in sudden cardiac death.

Clinical studies have evaluated the effects of many different nuts and peanuts on lipids, lipoproteins, and various CHD risk factors, including oxidation, inflammation, and vascular reactivity. Evidence from these studies consistently shows a beneficial effect on these CHD risk factors.

The LDL cholesterol-lowering response of nut and peanut studies is greater than expected, based on blood cholesterol-lowering equations that are derived from changes in the fatty acid profile of the diet. Thus, in addition to a favourable fatty acid profile, nuts and peanuts contain other bioactive compounds that explain their multiple cardiovascular benefits.

Other macronutrients include plant protein and fibre; micronutrients including potassium, calcium, magnesium, and tocopherols; and phytochemicals such as phytosterols, phenolic compounds, resveratrol, and arginine. Nuts and peanuts are food sources that are a composite of numerous cardioprotective nutrients and if routinely incorporated in a healthy diet,

population risk of CHD would therefore be expected to decrease markedly.

## Cardiovascular disease

Cardiovascular disease (CVD) is the leading cause of death in developed countries. Progress has been made in reducing death from CVD over the past 25 years. For example, in the US, the CVD mortality rate has decreased by 41% since the early 1980s. This reduction is associated with advancements in treatments as well as prevention.

Related to treatment is the rise in the number of hospital discharges for CVD since the 1970s, related in part to more angioplasties and bypasses being performed. Furthermore, there has been an increase in the incidence of heart failure (i.e. more people are living with progressive heart disease), which reflects advances made in treatment efforts.

With respect to prevention, the population-based decrease in LDL cholesterol (LDL-C) from the mid-1970s to 2002 is a good metric of the progress that has been made in decreasing CVD risk. Despite the 'progress' that has been made in decreasing the prevalence of CVD, the American College of Cardiology recently predicted that by 2050, the number of Americans diagnosed with CVD will double to 25 million.

This projection is troubling because it is predictive of what will likely occur worldwide. Thus, notwithstanding the advancements in reducing CVD death, a focus on prevention is key to a long-term decrease in CVD and the monetary burden associated with contemporary healthcare.

It is clear that lifestyle practices can have a marked impact on the prevention

of CVD. Diet remains the cornerstone of prevention efforts and impressive progress has been made in understanding how individual dietary factors, including nutrients and food, and dietary patterns modulate multiple CVD risk factors.

In recent years, tree nuts and peanuts have been shown to have cardioprotective effects and there is a large body of consistent evidence from epidemiological and controlled clinical studies demonstrating their multiple beneficial effects on CVD. This has been the impetus for research to determine the biological mechanisms that account for the cardiovascular benefits reported for nuts and peanuts.

## Epidemiological evidence

All epidemiological studies conducted in the US have reported a beneficial relationship between nut consumption and CHD incidence.

Peanut consumption was also associated with lower relative risk of CHD. Subjects who consumed peanuts 21 times per week had a relative CHD risk of 0,66 (CI: 0,46-0,94). For tree nuts, consumed 21 times per week, the relative risk was 0,79 (CI: 0,50-1,25). One mechanism by which tree nut and peanut consumption may decrease CHD risk is by decreasing inflammatory markers, thereby improving inflammatory status.

Inflammation is a key process in atherogenesis, among other diseases. In a cross-sectional study conducted by Jiang *et al.* using data from the Multi-Ethnic Study of Atherosclerosis, consumption of nuts and seeds was inversely associated with levels of inflammatory markers, C-reactive protein (CRP), interleukin (IL)-6, and fibrinogen.



This is important because inflammation contributes to all phases of atherosclerotic disease, ranging from initial recruitment of circulating leukocytes to induced endothelial dysfunction and plaque rupture.

### Clinical studies

The benefits of nut consumption on CHD risk reported by epidemiological evidence was the impetus for clinical studies designed to assess the effects on risk factors for CVD and to begin building an understanding of the underlying mechanisms that explained the observational data.

The first study was the Loma Linda University walnut study. Sabate *et al.* evaluated a blood cholesterol-lowering diet that provided 20% energy from walnuts and 31% energy from fat, of which 6% came from saturated fatty acids (SFA) and 16% from polyunsaturated fatty acids (PUFA). This was compared with a standard Step I diet that provided 30% of energy from fat, of which 10% was from SFA and 10% from PUFA.

The most studied nuts have been walnuts and almonds. Some research was conducted on peanuts, pecans, macadamia nuts, hazelnuts, and pistachios. These studies evaluated lipids, lipoproteins, and apolipoproteins. More recently, the effects of nuts on other emerging CVD risk factors were evaluated in clinical trials, including oxidative stress and inflammation.

By virtue of their unique fat and non-fat composition, nuts are likely to affect oxidative stress, inflammation, and vascular reactivity. In nut feeding trials effects on these markers of atherogenesis were studied less than the lipid and lipoprotein CVD risk factors. Nonetheless, the emerging picture is that frequent nut consumption has beneficial effects on CVD risk factors beyond cholesterol lowering.

### Nuts and oxidative stress

Nuts are important sources of tocopherols and phenolic antioxidants and protective effects of these dietary constituents on LDL oxidation have been well documented in human and animal

studies. Oxidative markers after feeding of MUFA-rich nuts were examined in several clinical trials. Results were inconsistent in studies involving almonds.

Berry *et al.* showed that oxidation of plasma and LDL lipids in healthy volunteers was less after an almond diet compared with a low-fat diet. Jenkins *et al.*, in a dose-response study comparing two doses of almonds with a low-fat diet in hyperlipidaemic subjects, observed a 14% reduction in plasma oxidised LDL levels after the higher dose (average 73g/d).

Diets enriched with peanut oil or peanuts plus peanut butter also improved LDL oxidisability compared with an average American diet rich in fat, but not compared with a low-fat diet.

Remarkably, in all nuts, most of the antioxidants are located in the pellicle or outer soft shell, and 50% is lost when the skin is removed. This fact, rarely taken into consideration in prior feeding trials with nuts, should not be overlooked in future studies.

Walnuts are an exception, because they are almost always consumed as the raw product with skins. Recent studies showed that almond and peanut skins are very high in antioxidants.

### Nut intake and inflammation

Plasma high-sensitivity CRP, an accepted measure of systemic low-grade inflammation, was a secondary outcome in several controlled nut feeding trials carried out in hypercholesterolemic subjects with almonds or walnuts. Three studies, two with almonds and one with walnuts, demonstrated a CRP-lowering effect.

However, two other studies reported no significant decrease in CRP. A more statistically powered trial also did not show an effect of the Mediterranean diet enriched with mixed nuts on circulating CRP levels. Then again, the plasma level of IL-6, a potent

inflammatory cytokine, decreased after the Mediterranean diet with nuts was compared with the control diet.

### Nuts and peanuts in a healthy diet

A healthy dietary pattern is high in fruit, vegetables, nuts, legumes, whole grains, and lean protein sources and low-fat dairy products. Nuts are a popular and important protein source in vegetarian diets. In a cohort of Seventh Day Adventists, Fraser reported that in vegetarians, after soft margarine on bread and green salads, nuts were next on the list of food most frequently consumed.

In fact, nuts were consumed more than meat substitutes. A well-balanced diet that includes nuts and peanuts can markedly benefit health, and in the context of this article, reduce CVD risk.

In summary, there is impressive evidence from epidemiological and clinical trials and *in vitro* studies of beneficial effects of nut consumption and their constituents on the risk of CVD, including sudden death, as well as on major and emerging CVD risk factors. The evidence to date is convincing that including nuts in a heart-healthy diet extends cardioprotective effects beyond those defined for a contemporary heart-healthy dietary pattern.

Importantly, these effects target multiple CVD risk factors and mechanisms, which help to explain why nuts so potently reduce CVD risk. Understanding the underlying biological mechanisms that explain the effects nuts have on multiple CVD risk factors may help in the design of the next generation of diets that include nuts to maximally reduce CVD risk. 🌱





# Partial substitution of maize with soya bean hulls in the concentrate for grazing dairy cows

By A van der Vyver, R Meeske and CW Cruywagen

*A typical concentrate for grazing dairy cows often consists of up to 70 to 80% maize grain. The price of maize grain varies depending on supply and demand. High maize prices make the use of less expensive sources such as by-products (Van Wyngaard et al., 2015) a viable option.*

Previous research at the Outeniqua Research Farm found that partial replacement of maize grain with highly digestible by-products such as bran, hominy chop and gluten 20 increased milk-fat percentage while milk yield was not compromised.

Soya bean hulls is a high-fibre by-product of soya beans. The hull is separated from the bean during the extraction process and can represent 8% of the total weight of the bean (Barbosa et al., 2008). Soya bean hulls are digested more efficiently by ruminants than by monogastrics (Barbosa et al., 2008).

Concentrates with high levels

of maize may compromise fibre digestion when fed at high levels to cows grazing high-quality grass. The aim of this study was to determine the effect of partial substitution of maize grain with soya bean hulls in concentrates for dairy cows, on milk production and milk composition.

## Materials and methods

The study was carried out at Outeniqua Research Farm near George, Western Cape, South Africa. George has a temperate climate with a long-term (50 years) mean annual precipitation of 730mm. The study was carried out

from 31 August 2017 to 2 November 2017 with a 14-day adaptation period and a 50-day measurement period.

The grazing camp of 8,6ha had permanent irrigation and kikuyu (*Pennisetum clandestinum*) as a base oversown with an annual Italian ryegrass, cultivar Yolande (*Lolium multiflorum*), at 24kg/ha during April 2017. After grazing, pastures were top-dressed with 100kg/ha limestone ammonium nitrate (LAN). The LAN contained 28% nitrogen (N), resulting in 28kg N/ha being applied after each grazing.

Pasture yield was estimated using a rising plate meter (RPM) and a

**Table 1: Mean ( $\pm$  s.d.) DIM, lactation number and milk yield of cows allocated to the three concentrate treatments (n=17).**

| Parameter <sup>1</sup> | Treatments <sup>2</sup> |            |              |            |              |            |
|------------------------|-------------------------|------------|--------------|------------|--------------|------------|
|                        | SH0                     |            | SH15         |            | SH30         |            |
| DIM                    | 125 $\pm$ 51            |            | 131 $\pm$ 54 |            | 124 $\pm$ 46 |            |
| Lactation no           | 3,59                    | $\pm$ 1,37 | 4,59         | $\pm$ 1,24 | 3,76         | $\pm$ 1,77 |
| Milk yield (kg)        | 19,7                    | $\pm$ 2,00 | 19,8         | $\pm$ 2,61 | 19,8         | $\pm$ 2,11 |

<sup>1</sup>DIM = days in milk. <sup>2</sup>Concentrates SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls, respectively.



seasonal regression equation:  $Y = 103 X H - 261$  ( $Y$  = available dry matter (DM) herbage (kg/ha) and  $H$  = RPM height reading). Cows grazed a new pasture strip after each milking and pasture was allocated at 10kg DM/cow/day.

A total of 51 multiparous Jersey cows were blocked according to milk yield three weeks prior to the study, DIM and lactation number (Table 1). Cows within a block were randomly allocated to one of the three concentrate treatments (Table 2) using a complete randomised block design.

Cows were separated into their treatment groups before milking and received 6kg/day of their allocated treatment concentrate in the milking parlour (3kg/milking). After milking, all cows grazed together as one group by



**Table 2: Ingredient composition of the three concentrates used in the study.**

| Ingredients (% of DM) <sup>1</sup> | Treatments <sup>2</sup> |       |       |
|------------------------------------|-------------------------|-------|-------|
|                                    | SH0                     | SH15  | SH30  |
| Maize meal                         | 80                      | 65    | 50    |
| Soya bean hull                     | 0                       | 15    | 30    |
| Wheat bran                         | 5,45                    | 5,92  | 6,4   |
| Molasses                           | 6                       | 6     | 6     |
| Soya bean oilcake                  | 5                       | 5     | 5     |
| Mono-calcium phosphate             | 0,4                     | 0,5   | 0,6   |
| Feed lime                          | 1,8                     | 1,5   | 1,2   |
| Salt                               | 0,5                     | 0,5   | 0,5   |
| Magnesium oxide                    | 0,3                     | 0,25  | 0,2   |
| Urea                               | 0,45                    | 0,23  | 0     |
| Premix                             | 0,1                     | 0,1   | 0,1   |
| ME (MJ/kg)                         | 12                      | 12,7  | 12,5  |
| Crude protein                      | 12,2                    | 12,2  | 12,3  |
| Ether extract                      | 3,21                    | 3     | 2,79  |
| NDF                                | 11,1                    | 19,8  | 28,5  |
| ADF                                | 4,45                    | 10,59 | 16,74 |
| Starch                             | 62                      | 51,4  | 40,8  |
| Calcium                            | 0,85                    | 0,86  | 0,87  |
| Phosphorous                        | 0,45                    | 0,45  | 0,45  |
| Magnesium                          | 0,36                    | 0,36  | 0,35  |

<sup>1</sup>ME = Metabolisable energy; NDF = Neutral detergent fibre; ADF = Acid detergent fibre. <sup>2</sup>Concentrates SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls, respectively.

means of strip grazing.

Milk yield was recorded daily and composite milk samples per cow were collected four times during the data collection period. Pasture and concentrate samples were collected weekly and pooled over two weeks for analyses at a

later stage. A pasture regression was also cut weekly. Live weight (LW) and body condition score (BCS) were determined at the start and end of the study.

## Results and discussion

The chemical composition of concentrates and pasture is reflected in Table 3. As the level of soya bean hulls increased in the concentrate, the NDF and acid detergent

**Table 3: Mean ( $\pm$  s.d.) chemical composition of the three concentrate supplements used in the study and pasture samples collected over a seven-week period on a dry matter basis.**

| Parameter <sup>1</sup> (% of DM) | Treatments <sup>2</sup> |       |       | Pasture |
|----------------------------------|-------------------------|-------|-------|---------|
|                                  | SH0                     | SH15  | SH30  |         |
| DM                               | 92,1                    | 91,8  | 91,7  | 16,4    |
| Ash                              | 5,02                    | 5,18  | 5,68  | 10,3    |
| CP                               | 10,9                    | 10,9  | 11,3  | 19,4    |
| NDF                              | 8,05                    | 16,3  | 24,6  | 43,7    |
| NDIN                             | 0,572                   | 0,929 | 1,15  | 1,93    |
| ADF                              | 3,1                     | 10,3  | 17,2  | 27,6    |
| ADIN                             | 1,3                     | 0,635 | 0,439 | 0,98    |
| ADL                              | 0,515                   | 0,711 | 1,09  | 5,39    |
| Ca                               | 0,826                   | 0,769 | 0,885 | 0,455   |
| P                                | 0,386                   | 0,392 | 0,408 | 0,406   |
| Mg                               | 0,352                   | 0,353 | 0,364 | 0,399   |
| K                                | 0,808                   | 1     | 1,15  | 2,24    |

<sup>1</sup>DM = Dry matter; CP = Crude protein; NDF = Neutral detergent fibre; NDIN = Neutral detergent insoluble nitrogen; ADF = Acid detergent fibre; ADIN = Acid detergent insoluble nitrogen; Ca = Calcium; P = Phosphorous; Mg = Magnesium; K = Potassium. <sup>2</sup>Concentrates SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls, respectively.

**Table 4: Mean milk yield, milk composition (fat, protein, lactose, SCC and MUN), live weight and body condition score of cows receiving a different concentrate supplement (n = 17).**

| Parameter <sup>1</sup>  | Treatments <sup>2</sup> |       |       | SEM <sup>3</sup> | Contrasts <sup>4</sup> |        |        |
|-------------------------|-------------------------|-------|-------|------------------|------------------------|--------|--------|
|                         | SH0                     | SH15  | SH30  |                  | 1 vs 2                 | 1 vs 3 | 2 vs 3 |
| Milk yield (kg/cow/day) | 19,3                    | 19,4  | 19,2  | 0,44             | 0,98                   | 0,79   | 0,78   |
| 4% FCM (kg/cow/day)     | 22,4                    | 23,5  | 23    | 0,61             | 0,23                   | 0,51   | 0,58   |
| ECM (kg/cow/day)        | 23,9                    | 25    | 24,5  | 0,6              | 0,21                   | 0,45   | 0,61   |
| Fat (%)                 | 5,12                    | 5,48  | 5,33  | 0,127            | 0,06                   | 0,26   | 0,41   |
| Protein (%)             | 3,67                    | 3,81  | 3,82  | 0,046            | 0,04                   | 0,03   | 0,82   |
| Lactose (%)             | 4,55                    | 4,74  | 4,75  | 0,036            | 0                      | 0      | 0,79   |
| SCC (x 1000/mL)         | 164                     | 205   | 201   | 47,6             | 0,55                   | 0,58   | 0,96   |
| MUN (mg/dL)             | 8,3                     | 8,54  | 9,36  | 0,256            | 0,5                    | 0,01   | 0,03   |
| LW before (kg)          | 386                     | 389   | 389   | 10,1             | 0,86                   | 0,88   | 0,98   |
| LW after (kg)           | 422                     | 426   | 419   | 10,5             | 0,75                   | 0,84   | 0,6    |
| LW change (kg)          | +35,4                   | +37,6 | +30,1 | 2,64             | 0,56                   | 0,17   | 0,06   |
| ADG (kg/day)            | 0,55                    | 0,59  | 0,47  | 0,041            | 0,56                   | 0,17   | 0,06   |
| BCS before              | 2,15                    | 2,09  | 2,18  | 0,037            | 0,28                   | 0,58   | 0,11   |
| BCS after               | 2,24                    | 2,31  | 2,26  | 0,039            | 0,19                   | 0,6    | 0,43   |
| BCS change              | +0,09                   | +0,22 | +0,09 | 0,038            | 0,02                   | 1      | 0,02   |

<sup>1</sup>FCM = Fat corrected milk; ECM = Energy corrected milk; SCC = Somatic cell count; MUN = Milk urea nitrogen; LW = Live weight; ADG = Average daily gain; BCS = Body condition score. <sup>2</sup>Concentrate SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls (SH), respectively. <sup>3</sup>SEM = Standard error of the mean. <sup>4</sup> $p \leq 0,05$  = significant difference;  $p > 0,05-0,10$  = significant trend.

**Table 5: Milk price, income and monthly increase in profit if 0, 15 or 30% of maize is replaced with soya bean hulls in concentrates for 400 Jersey cows grazing ryegrass during spring.**

|                            | SH0        | SH15       | SH30       |
|----------------------------|------------|------------|------------|
| Milk price R/kg            | R5,21      | R5,41      | R5,39      |
| Milk production kg/cow/day | 19,3       | 19,4       | 19,2       |
| Milk income R/month        | R1 206 636 | R1 259 448 | R1 241 856 |
| Milk profit/month increase | -          | R52 812    | R35 220    |

Concentrate SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls, respectively.



fibre (ADF) increased substantially (Table 3). The crude protein (CP) was similar for the different concentrates. The pasture was of high quality as indicated by the CP and NDF content.

Production data is presented in Table 4. Milk yield, 4% fat corrected milk (FCM) and energy corrected milk (ECM) was not affected by the inclusion of soya bean hulls in the concentrates. There was a tendency ( $P=0,06$ ) for the milk fat percentage to be higher on the SH15 treatment compared to the SH0 control.

The replacement of maize with soya bean hulls resulted in significant increases ( $p < 0,05$ ) in milk protein and lactose content. The milk urea nitrogen (MUN) content indicates that protein in the total diet was sufficient for all the treatments.

Cows on all three treatments gained in body weight, but no significant ( $p > 0,05$ ) differences were found between treatments. Body condition score of cows on all three treatments did increase with a significant difference ( $p < 0,05$ ) between the 15% soya bean hull concentrate treatment and the other two treatments.

### Economic implications

Milk composition and production data was given to our milk buyer to determine milk prices for three concentrate treatments. If a dairy farmer is milking 400 cows, supplement concentrate at 6kg/cow/day and the cost of soya bean hulls is the same as that of maize grain, the income benefit is shown in Table 5.

### Conclusion

Soya bean hulls have great potential as feed source to partially replace maize grain in concentrates for grazing dairy cows in spring. Milk production was not compromised while milk protein and milk lactose content increased. Higher milk prices can be expected due to the positive effect of soya bean hulls on milk solids. 🌱

For more information and references, contact Prof Robin Meeske at [RobinM@elsenburg.com](mailto:RobinM@elsenburg.com).



# Performance of imported vs local soya bean meal evaluated

By Prof Rob Gous, Protein Research Foundation

*An evaluation trial in which the performance of three South African soya bean meals was compared with the performance of an Argentine soya bean meal in broiler rations, was conducted independently at the University of KwaZulu-Natal in Pietermaritzburg during July 2018.*

The objective of the trial was to determine whether the three local soya bean oilcake meals are of similar quality and can produce broiler performances equal to that of Molinos soya bean meal imported from Argentina.

Most of the soya bean meal that has been imported to South Africa for the last 20 years, has been produced by Molinos. The soya bean meal is regarded as very high quality, delivering excellent broiler performance.

The three South African soya bean meals were sourced from three factories that have a reputation for producing good quality soya bean meal in quantities that can satisfy a large percentage of the South African soya bean meal demand.

## Materials and methods

Day-old broilers were obtained from a local hatchery (National Chicks, Umlaas Road). The broilers were sexed and vaccinated at the hatchery before being despatched to the research farm in Pietermaritzburg. The 2 880 chicks were distributed randomly to 48 floor pens in a tunnel ventilated broiler house with 60 chicks per pen, and with males and females in alternate pens throughout the house.

The four feed treatments (four soya bean oilcake meals), treatment A, B, C (Molinos Argentina) and D, were randomly distributed among the pens within each of the four blocks running the length of the house – each block contained two replications of each feed x sex treatment. The four soya bean meals were analysed for protein, fat, fibre, moisture and ash.

Processing quality of the soya bean meals used in the treatments was analysed using various methods. Results are indicated in *Table 1*:

**Table 1: Processing quality parameters of soya bean meals used in the trial.**

| Treatment | A    | B    | C    | D    |
|-----------|------|------|------|------|
| TIU/mg    | 1,78 | 1,35 | 1,63 | 2,35 |
| KOH       | 77,7 | 73,6 | 74,1 | 76,7 |
| PDI       | 25,2 | 22,6 | 17,9 | 24,6 |
| Lysine R  | 2,47 | 2,53 | 2,50 | 2,54 |
| Evonik I  | 15   | 13   | 12   | 14   |
| Urease    | 0,08 | 0,02 | 0,02 | 0,12 |

Proximate analysis of the soya beans was used to formulate a starter feed that contained approximately 400g soya bean oilcake/kg and a finisher feed that contained approximately 300g soya/kg, with the same calculated final feed nutrient composition. Feeds were mixed at Ukulinga Research Farm.

The starter feed was offered at 21 days of age and thereafter the finisher feed was allocated. The trial was terminated at 28 days of age. The

temperature in the house was kept at 31°C for the first two days and then reduced daily to reach 21°C by 21 days of age. The temperature was maintained at 21°C for the remainder of the trial. The lighting programme used was 12L:12D.

Birds were weighed weekly and feed consumed each week was calculated from the amount of feed allocated and the feed that remained.

## The results

The analysis of the four soya bean oilcake samples indicated small differences in proximate analysis, which were compensated for in the formulations. The small differences between soya bean meals in treatment B and C resulted in similar formulations.

The processing parameters showed differences with TIU ranging from 1,35mg to 2,35mg. The Evonik processing index indicated that differences were between 15 for the least processed to twelve for the most processed soya bean meal. All soya bean meal sources used in treatments were within acceptable parameters.



**Table 2: Mean body weights (g), feed intake (g) and FCR (g/g) to 28 days, males (M) and females (F).**

|                 | A     |       | B     |       | C                 |       | D     |       |
|-----------------|-------|-------|-------|-------|-------------------|-------|-------|-------|
| Treatment       |       |       |       |       | Molinos Argentina |       |       |       |
|                 | M     | F     | M     | F     | M                 | F     | M     | F     |
| 28 days weight  | 1 700 | 1 471 | 1 719 | 1 488 | 1 668             | 1 463 | 1 696 | 1 463 |
| Feed to 28 days | 2 212 | 2 961 | 2 199 | 2 030 | 2 198             | 2 010 | 2 185 | 1 950 |
| FCR 28 days     | 1,30  | 1,28  | 1,28  | 1,37  | 1,32              | 1,37  | 1,29  | 1,33  |

No significant difference between treatments.

**Table 3: Treatment means males and females combined.**

|                 | A     | B     | Molinos | C     |
|-----------------|-------|-------|---------|-------|
|                 | Mean  | Mean  | Mean    | Mean  |
| 28 days weight  | 1 587 | 1 604 | 1 566   | 1 580 |
| Feed to 28 days | 2 086 | 2 114 | 2 104   | 2 067 |
| FCR 28 days     | 1,317 | 1,325 | 1,346   | 1,311 |
| Mortality %     | 0,33  | 0,67  | 0,75    | 0,83  |

No significant difference between treatments.

As a result, there were no differences in growth, feed intake or feed conversion ratio

(FCR) between treatments at any stage during the trial (*Table 2*). The mortality recorded for each treatment at 28 days was less than 1% and showed no differences between treatments (*Table 3*).

### Conclusions

The mean body weights and FCR's recorded in this trial were excellent, suggesting that the feeds

and environmental conditions were such that the broilers could achieve growth rates close to their potential.

Broilers grown on all of the locally produced soya bean oilcake performed as well as those on Molinos oilcake obtained from Argentina, confirming that the processing quality of these meals was sufficient to sustain broiler production equal to that of the imported meal.

Despite differences in processing parameters the results indicate that these differences were not large enough to have any significant effect on the performance parameters of high performing broiler chickens. 🍳

This article is an extract from the full trial report that contains more detail. Contact Prof Gous at [gous@ukzn.ac.za](mailto:gous@ukzn.ac.za) for more information.

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