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OILSEEDS focus

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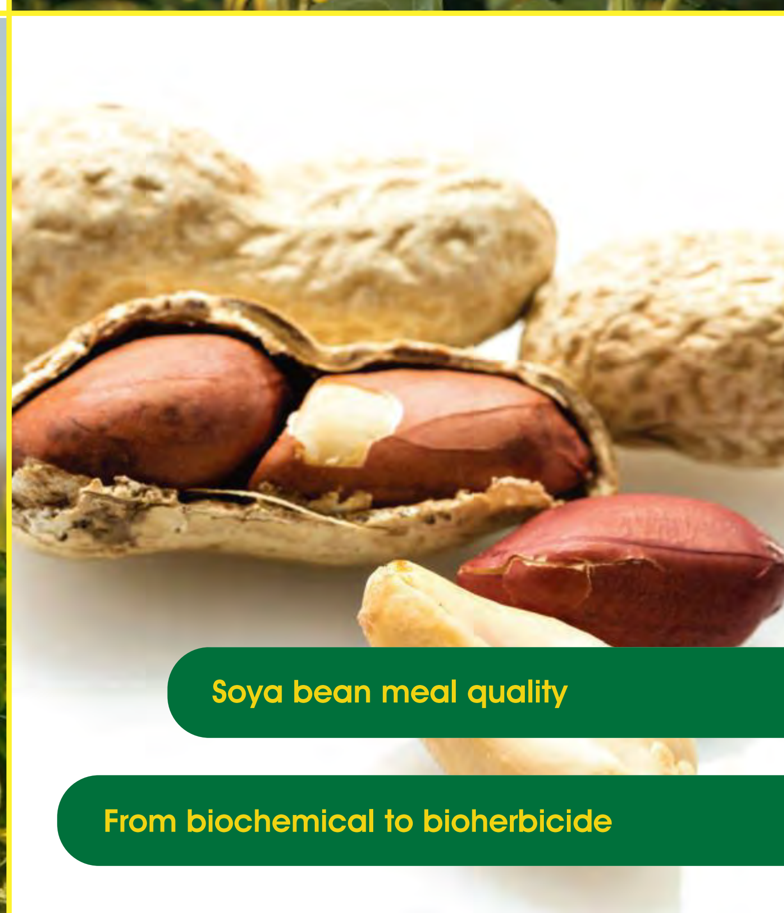

Plant disease surveillance

Soya bean meal quality

Climate change and Swartland canola

From biochemical to bioherbicide

Underestimating pressure

By Izaak Breitenbach, general manager: Broiler Organisation, South African Poultry Association

While new anti-dumping duties were published in the 3 August edition of the *Government Gazette*, a cloud of uncertainty continues to hang over the country's poultry sector.

Nothing illustrates this uncertainty better than the fact that large poultry companies are no longer gambling big when it comes to investing money in the sector. A few months ago, we believed we could count on a significant R600 million investment from the poultry industry on the back of promises made in the Poultry Master Plan.

Today, however, that amount has shrunk to R280 million after Astral Foods decided to rather put its expansion plans on hold. And who can blame them? The sector has been bleeding for months.

Influence of input pressures

Input factors such as load shedding and soaring grain prices have also had a disastrous impact on the local poultry industry's margins. Load shedding alone contributes substantially to the price of locally produced poultry, with anti-dumping duties adding a few cents on selected imports.

Even after the suspension of these duties, we saw net profit margins continue to fall sharply. This was largely driven by a significant increase in costs. The South African Poultry Association (Sapa) commissioned Genesis Analytics to perform a study to determine the potential passthrough of any corrective trade measures to consumers. As part of the commission, Genesis Analytics were also instructed to investigate alternative reasons for cost increases.

The report found that a likely driver for these cost trends was live bird costs. This includes the cost of feed and day-old chicks, and accounts for more than 70% of production costs. The weighted average per unit live bird cost for the country's six largest poultry producers rose by 24% from January 2022 to March 2023.

The stark picture of a local poultry industry under pressure continued during the provisional period and remained more or less the same as the six months prior (July to December 2021), when the average gross margins relating to bone-in portion across six of the largest producers almost halved. This decline in profitability continued throughout the second half of 2022.

Net margins were negative in the pre-duty period and remained below zero during the provisional period. South Africa is rated as one of the top three most competitive poultry producers in the world, but no one can compete with dumping.

Dumping's deadly impact

Whereas the minister of trade, industry and competition, Ebrahim Patel, expressed concern over the fact that food prices might rise if anti-dumping duties were implemented, the Genesis Analytics report showed that the opposite would be the economic reality.

After all, the further suspension of tariffs would have had a far costlier outcome for South Africans than this passthrough of anti-dumping duties. While the effects of dumping are well documented (it eviscerated Ghana and Cameroon's poultry industries in a few short years), the empirical evidence from the knock-on effects of corrective trade measures is far too limited.

During the period when provisional duties were implemented by the International Trade Administration Commission (ITAC), Brazil was the only dumping country in a position to do so. This is because this period coincided with a massive outbreak of highly pathogenic avian influenza in Europe. Brazil was therefore effectively the only country subject to the provisional duties during the six months in which these duties were imposed.

As Brazil represented only roughly a third of bone-in imports between January and June 2022, the cost of around two-thirds of bone-in imports would have been unaffected by the provisional duty – significantly diluting its potential effects.

Izaak Breitenbach, general manager of Sapa. (Photograph: Poultry Bulletin)

Could tax offer a solution?

The fact remains that economic conditions are placing extreme pressure on South Africa's poorest people and something must be done in this regard. Most of our local producers are already subsidising many of their production costs to offer South African consumers the cheapest poultry meat money can buy. This is, however, not sustainable.

We need immediate relief for our most vulnerable. Hence, we remain firm on our position that government should consider scrapping value-added tax (VAT) on selected poultry products – the load shedding tax is already too much. It is evident that this removal of anti-dumping duties will have little to no impact on the poorest of the poor, while the businesses of integrated producers and emerging poultry producers will remain in jeopardy.

For more information, contact SAPA on 011 795 9920 or visit *www.sapoultry.co.za*.

Local value chain excels

On the international front, the bombing of Ukraine's grain facilities by Russia in the Black Sea is cause for concern and has a major influence on grain prices. Russia continues to attack Ukraine's grain facilities and there is some doubt whether they have any interest in getting the Black Sea grain corridor working again.

United States' (US) weather predictions indicate substantial amounts of short-term rain. The improved weather and lower export volumes will assist in putting pressure on oilseed prices.

World production of soya beans is expected to reach a surplus in 2023/24 even with lower than anticipated production in the US. However, the demand for soya bean products is expected to increase after 2022/23 experienced a record low decline of usage to 245 million tons due to subdued livestock consumption and loss of market share to other oil meals.

World production of canola is expected to decrease by 1,8 million tons due to a reduction in the Canadian crop. World rapeseed production is anticipated to be close to 76 million tons. Growth in the world's canola, palm and sunflower seed output is expected to slow down in the current season.

The local outlook

Hectares of canola increased from 123 510ha in 2022 to an estimated 128 100ha in 2023 and with favourable rainfall, we can expect an excellent canola crop in South Africa this year.

The South African oilseed industry reached a milestone in April 2023 with the last vessel of Argentine soya bean meal reaching our shores this year. In 2022, imported soya bean meal dwindled to 183 603 tons, and was almost surpassed by exports of 180 937 tons.

Last year 1,7 million tons of soya beans were crushed for oil and oilcake while the anticipated crush for this year is approximately 1,8 million tons. This will produce a possible 1,4 million tons of soya bean meal which means that for the first time in our history we should be self-sufficient in South Africa. This is indeed a major achievement by all in the value chain.

This issue of *Oilseeds Focus* once again celebrates advances in oilseed production, processing and nutritional value. Enjoy the read.

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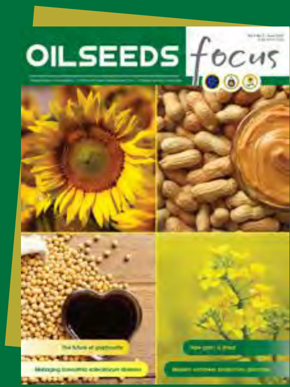

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Soya products promoted at schools

Addressing the issue of food security in South Africa, Dr Brandon van Rooyen from the Department of Sustainable Food Systems and Development and manager of the Food Innovation Laboratory at the University of the Free State (UFS), teamed up with Wilna Oldewage-Theron, professor of Nutrition from Texas State University and research fellow in the UFS Department of Sustainable Food Systems and Development, to develop nutritious products tailored to the needs of the low-income population.

A big focus of the Food Innovation Laboratory is soya products. Since the lab opened its doors at the beginning of 2023, it has developed a range of plant-based products resembling meat, including soya sausages and mince. "Should the soya sausages, for instance, be made available in schools and served as hotdogs, the bread bun will cost more than the sausage," indicated Dr Van Rooyen, who is of the opinion that their products tick all the boxes of affordability, nutrition and being attractive to the consumer.

The lab is currently distributing these products to schools and conducting surveys to gather feedback from students. The feedback will be valuable in assessing how the products are being received and determining if any adjustments are necessary. – *Press release, University of the Free State*

The need for accurate data increases

According to the annual report of the South African Grain Information Services (Sagis) for the 2022/23 financial year, which was presented at their recent annual general meeting, the need for accurate comprehensive data globally continues to increase. The application of technical knowledge and information, including business skills, has become critical for progress and survival in the value chain. Systems continue to be developed to assist with predictions on weather, yields and economics including precision farming.

According to Dr Erhard Briedenhann, chairperson of the Sagis board of directors, climate change will present challenges to crop production in the future. "It is now, during these very uncertain times and adverse climatic conditions, that stock information available to the market is essential in decision-making. With larger stocks currently required to be exported, prices will fluctuate at or above export parity depending on surplus removal," he said.

Continuous upgrading and changes on the systems used by Sagis ensure that correct data is reported. In addition to this, Sagis follows up on any differences reported, while inspectors visit co-workers to do physical audits. "The country has faced some very difficult economic years, the current challenges on safety, infrastructure and necessities such as electricity and water pose a large hurdle for conducting business as usual. Through these difficult times, Sagis will continue to supply correct data, as cost-effectively as possible to the industry," said Briedenhann. – *Elmarie Helberg, Plaas Media*

Multiple factors drive soya bean prices

There is no clear direction in the movement of soya bean prices. On the one hand weather conditions are putting pressure on the price, whereas on the other the conflict in the Black Sea region is supporting the price.

The weather in the United States (US) is putting price pressure on soya beans in the short term. Cooler and wetter weather is expected this month in key US production regions, which will benefit crops. Due to dry warm weather, crops are not doing as well as they were a year ago. The US Department of Agriculture (USDA) estimated that last weekend, 54% of soya beans were in "good to excellent" condition. That is 2% higher than the estimation a week earlier. And a year ago, 59% of US soya beans were in "good to excellent" condition at the beginning of August.

Looking further ahead, substantial soya bean production is expected in Brazil in the 2023/24 season. Brazilian growers are expected to sow a larger area of soya beans, allowing production to grow by almost 4% to 163,5 million tons. This is reported by the market agency Stonex. – *All About Feed*

Floods in China raising food security concerns

Days of torrential rain and the aftermath of typhoon Doksuri caused severe flooding in China's leading grain-producing region in the northeast, resulting in 14 fatalities and concerns regarding food security due to inundated farmlands.

The region's fertile farmlands in Heilongjiang province have been affected, submerging rice fields, damaging factories and causing damage to vegetable greenhouses. The floods have raised concerns regarding China's agricultural production and food security, given the significance of the three most northeastern provinces in the country's grain output.

Major crops produced in the region include soya beans, maize and rice. The short-term impacts are expected to affect food prices, which had been relatively stable in recent months. China has faced various weather-related challenges to its agriculture sector, including droughts and heatwaves in the past year, which affected crop growth and production. The situation has prompted the country to prioritise food security, recognising agriculture's role as the foundation of national security. – *CNN*

Global food price index increases

The Food and Agricultural Organization (FAO) of the United Nations released its July update of the global food price index, registering a 1,3% increase from June to 124 points (still, the prices are down 12% year-on-year).

This marginal monthly rebound was due to an uptick in the vegetable oils price index, mainly sunflower, palm, soya bean and rapeseed oils, which offset the decline in other product prices. Russia's decision not to renew the Black Sea grain deal has contributed to the increase in sunflower oil prices. Regarding palm oil prices, the surge reflects worries regarding the reduced supplies in leading producing countries because of unfavourable weather conditions.

The soya bean and rapeseed price uptick reflect the concerns that the heatwave in parts of the US and Canada could reduce the harvest. The two crucial events of the past month, which are the non-renewal of the Black Sea grain deal and India's ban on exports of non-basmati and broken rice, are not fully reflected in the prices of July as the events occurred towards the end of the month. The August 2023 price data will better reflect this challenge. – *Wandile Sihlobo, Agbiz*

Bayer Crop Science changes leadership

Bayer Crop Science Europe, the Middle East and Africa (EMEA) has announced important changes in its leadership team and in the Southeast Africa region following the retirement notice of one of its senior leaders.

Dr Klaus Eckstein, senior Bayer representative Southeast Africa and Crop Science EMEA cluster division head Africa, will retire from Bayer after 25 years of service. He will remain with the company as senior Bayer representative until 30 November 2023. Prior to this, he will hand over the Crop Science EMEA cluster lead role in Africa to his successor, Debra Mallowah, as of 1 September 2023. Mallowah will be based in Nairobi, Kenya. – *Press release, Bayer Crop Science Africa*

China's soya bean imports climb

China's July soya bean imports jumped by almost one quarter from a year ago, official data showed, boosted by improved demand in the world's biggest buyer, especially for use in animal feed and by higher arrivals from Brazil.

Arrivals for the first seven months of the year came to 62,3 million metric tons, up 15% from the previous year. The increase was driven by higher demand for soya meal, a protein-rich animal feed ingredient made from soya beans and cooking oil, analysts said.

Chinese pig producers delayed the slaughter of pigs due to low pork prices, which in turn increased demand for animal feed, said Wang Mingwei, a Hangzhou-based analyst at Dayue Futures. Soya meal prices in China have risen 23% since the end of May, hovering at 4 500 Chinese Yuan per metric ton. – *The Pig Site*

Liesl Breytenbach (right) has been appointed the new executive director of AFMA. On the left is Anina Hunter, chairperson of AFMA.

Liesl Breytenbach to head AFMA

Liesl Breytenbach has been appointed as the official executive director of the Animal Feed Manufacturers' Association (AFMA). This was recently announced by AFMA's chairperson, Anina Hunter. Breytenbach has been standing in as the interim executive director since the beginning of the year. Her formal appointment follows the retraction of Dr Sifiso Ntombela's acceptance of the post a month ago.

Liesl holds an MSc degree in agriculture (monogastric nutrition) from Stellenbosch University and joined the animal feed industry in 2004 as a formulator at Meadow Feeds in Port Elizabeth. In 2011, she joined AFMA as a technical assistant and has since been applying her passion for the industry in the fields of nutrition and feed legislation.

In 2015, she was promoted to the management team of AFMA as technical and regulatory manager and shifted her focus to creating an enabling environment for feed businesses in South Africa. With almost 20 years' experience in the animal feed industry, Breytenbach brings vast experience and knowledge to the AFMA team. – *Press release, AFMA*

The climate's effect on Swartland canola production

By Stephanie JE Midgley, Andries A le Roux, Pieter A Swanepoel, Johann A Strauss, Piet Lombard and Michael Wallace

Dryland canola production potential is highly influenced by climatic factors such as temperature, carbon dioxide (CO_2) concentration and rainfall amount and distribution, in addition to soils, agrochemical inputs and management.

In the Western Cape, information on the climate drivers of canola growth and seed production can help to decrease the yield gap by identifying current and future areas of medium to high production potential. Furthermore, knowledge of expected future climate risks to canola production can be used to mitigate the risks and implement adaptations.

Canola in the Swartland region

Canola is an important dryland crop in the winter-rainfall Swartland region of South Africa and is widely employed within crop rotation systems. The potential production of canola in terms of yield and suitable planting areas has not yet been exploited under current climatic conditions, i.e., there is a 'yield gap'.

However, the climate is already changing, and future production potential and suitable areas are very likely to change. This could be both challenging and provide opportunities for production and efficiency increases for this growing commodity.

The range of genetic types available to South African producers, encompassing cultivars that have been bred for specific herbicide tolerances and cultivars with short to long growing seasons, could provide tools for adaptation and sustainable growth of the industry. While some research in Australia and Canada has focussed on canola responses to climatic factors and climate change, no information is available for the South African context.

Recent research conducted for the Western Cape Department of Agriculture (WCDoA) confirms that the Mediterranean-type climate of the Western Cape, where most of the rainfall occurs in the cool months of April to September, is getting hotter (Jack *et al.*, 2022). The trend in rainfall amounts and seasonal distribution is more complex, with indications that autumn (the canola planting season) is getting dryer, especially in the western parts of the province.

When climate modelling was conducted for various climate change scenarios for the mid-century, the results were consistent with modelling for other Mediterranean climate regions where canola is produced. The future climate of the Swartland will be increasingly warmer, with more hot days and dry spells, and likely with longer-term decreases in seasonal rainfall.

Climate change is driven largely by emissions of CO_2 into the earth's atmosphere, which is also an important factor to consider when studying the response of canola plants to current and future climate. This article provides a brief background to a research project currently underway.

A climate study

In a quest to unlock the full potential of canola cultivation, scientists from the WCDoA and Stellenbosch University (SU) are currently conducting a study to explore the potential impact of climate change on canola crops in the Swartland, and to assess the present and future canola production potential for the region.

The study focusses on increases in temperature and atmospheric CO_2 concentration. In addition, they are investigating how climate variations affect the actual yield of various canola cultivar types in field trials. The Protein Research Foundation or PRF financially supports the project. By understanding the interplay between climatic factors and canola cultivar types, strategies that will optimise canola yields can be developed to ensure its successful cultivation, despite changing environmental conditions.

Andries le Roux, a PhD student from the Department of Agronomy at SU, is conducting the research in three parts, supported by the larger research team. Firstly, the effect of current and future climate on canola production in the Swartland region is explored through a series of pot trials inside a climate-controlled phytotron. Two crucial climatic factors – air temperature and atmospheric CO_2 concentration – are simulated for current and future scenarios.

Secondly, the study focusses on canola production under field conditions to build upon and test the results of the phytotron experiments. Over the past 12 years, canola cultivar trials have been conducted by researchers at the WCDoA, particularly at Langgewens Research Farm near Moorreesburg. Precise measurements of canola yield, together with weather and other environmental factors, have been recorded for the various cultivars included in these trials. Further canola trials and detailed data collection at Langgewens are planned for the next three years as part of this project.

The canola cultivars used in the pot and field trials are categorised into distinct classes based on two factors: growing season length (short and medium for pot trials; and short, medium and long for field trials) and cultivar type (conventional, Clearfield tolerant and triazine tolerant). Climate data including day and night temperatures, stress-inducing (high) temperatures during certain critical growth stages, and rainfall patterns during different growth stages will be meticulously analysed concerning crop phenological development and yield.

The third part of the study will entail canola crop modelling employing the agricultural production systems simulator (Apsim) model to establish the current and simulated future canola production potential in the Swartland. Apsim is an integrated model that effectively mimics biophysical processes in agricultural systems, considering ecological outcomes of various management practices for the present climate and climate change. It encompasses plant, soil and management modules, accommodating a diverse range of crops, soil profiles and management practices suited to Australian conditions.

By incorporating South African canola cultivars, Swartland's predominant soil profiles, climate and diverse management practices, the model will be adjusted to simulate the current canola production potential for this locality. Subsequently, different climate change scenarios and a suite of Global Circulation Models will be employed with the model to project the canola production potential and possible changes in suitability across the Swartland region between 2046 and 2065.

Climate's influence on canola

Canola production, like many dryland crops, is influenced by the region's local climate, including day or night temperatures, and rainfall amount and distribution during the production season. The ideal growing temperature for canola is between 20 to 25°C, while rainfall of less than 450mm during the production season can result in yield penalties (Robertson and Kirkegaard, 2005).

Climate plays a significant role in canola production right from planting, where it is advisable to sow canola after a sufficient rainfall event or at least 10mm (with prior rainfall) to 20mm over a week. Early seasonal planting, with warmer soil temperatures, can improve seedling establishment and growth, along with increasing the vegetative growing season length, ultimately enhancing canola production (Shafighi *et al.*, 2021). Conversely, late planting due to delayed rains in cooler soils negatively affects initial growth and results in reduced seed yield, size and oil content.

During the vegetative growth stage, the environment continues to play a key role in canola production, particularly concerning plant biomass production, which directly affects yield. Optimal temperatures during this stage promote canola leaf growth and biomass production, leading to higher seed yields. While canola is more drought tolerant during its vegetative stage compared to certain other crops, prolonged water stress can still affect leaf area, though recovery occurs with adequate rains.

Temperature and drought stress during the reproductive growth stage have a more severe impact on canola production than during the vegetative stage. Heat stress, typically observed at temperatures higher than 30°C during flowering and seed set stages, leads to flower abortion and infertility, reducing the number and mass of siliquae per plant (Dreccer *et al.*, 2018). Moreover, it negatively alters the oil extraction percentage and fatty acid composition of the oil.

Similarly, drought stress during flowering and seed set causes flower abortion, shortens the flowering period and delays siliqua maturity, ultimately affecting pod numbers and seed size, leading to reduced canola production and decreased seed quality, including oil extraction and fatty acid composition (Elferjani and Soolanayakanahally, 2018).

Future climate effects

A review of the scientific literature was conducted to provide a basis for what we can expect in future as the climate changes in the Swartland.

The rise in global greenhouse gas (GHG) emissions, particularly CO_2, has already caused an increase in the global average temperature of 1,1°C since preindustrial times, with projections of further GHG-driven temperature increases of approximately 1 to 2°C and shifting rainfall patterns within the next few decades for the Swartland region. This would lead to more frequent dry spells and droughts, altered seasonal rainfall distribution, and amount and increased occurrences of extremely hot days and heatwaves (Jack *et al.*, 2021). Canola is more sensitive to stressful environmental conditions during the reproductive phase than the vegetative phase.

Elevated atmospheric concentrations of CO_2 have a fertilising effect on C_3 plants such as canola, enhancing plant photosynthesis and increasing leaf area and plant biomass, and ultimately improving canola production. However, studies have shown that higher CO_2 levels can cause canola plants to allocate more energy towards vegetative growth rather than reproductive growth, leading to an extended flowering period (Qaderi *et al.*, 2006).

Research specific to the Swartland region indicates the likelihood of a later planting date, an increased occurrence of very hot days and heatwaves during the flowering period, and more regular dry spells throughout the production season. While elevated atmospheric CO_2 levels may partially offset the negative effects of heat and drought stress on canola yield, the potential extension of the flowering period under elevated CO_2 levels means that temperature and drought will continue to play a critical role in determining canola yield and seed quality in future.

We thank the Protein Research Foundation for funding this research project.
For more information and references, email Stephanie Midgley at Stephanie.Midgley@westerncape.gov.za.

The art of war on plant disease through surveillance

By Nomvula Moloi and Lisa Rothmann, University of the Free State, Plant Pathology, Bloemfontein

"The art of war teaches us to rely not on the likelihood of the enemy not coming, but on our own readiness to receive that enemy; not on the chance of the enemy not attacking, but rather on the fact that we have made our position unassailable."
– Sun Tzu, Art of War

Plant biosecurity is an array of strategies and measures designed to assess and manage the risk of plant diseases and to protect crops from emerging plant pests and diseases at pre-border, border and post-border. Official international activities to restrict the entry and spread of plant diseases are facilitated by the International Plant Protection Convention (IPPC), administered by the United Nations Food and Agriculture Organization (FAO).

Passive and active surveillance

Surveillance is essential in plant protection and crucial for crop production to monitor existing and detect new and emerging pests and diseases. The successful management of incursions relies on timely surveillance and is the cornerstone of any plant biosecurity system. Passive and active surveillance are processes that collect and record data on disease occurrence or absence by survey, monitoring or other procedures. Reliable, fast and effective disease surveillance over large regions is crucial for assessing plant protection and disease management.

Phakopsora pachyrhizi on soya beans.

Passive surveillance is the detection of pests and crop diseases by members of the public, usually by chance or at their convenience and is reported to the relevant authorities. An intermediary between passive and active surveillance is known as citizen science – it can be targeted and non-targeted. The Cape Citizen Science project, currently supported by the Forestry and Agricultural Institute (FABI) initiated a project that enlists the assistance of the public to identify a group of plant pathogens called *Phytophthora* in the Greater Cape Floristic Region (GCFR) that were destroying some of the fynbos species in the region.

This project involves members of the public who share their observations and report dying or potentially infected plants that they encounter while carrying out 'personal' activities in the mountains. Participating members can also submit samples that could potentially result in discovering novel *Phytophthora* species, especially in areas the project's organisers cannot access.

A close-up of Phakopsora pachyrhizi.

In contrast, active surveillance is carried out by the trained staff to identify and sample for regulated and quarantine pests and diseases at targeted locations, following a structured design to give a statistical framework and facilitate interpretation of the resulting data. Regulatory and pest detection surveys are routine and aim to establish a 'pest-free' or 'disease-free' area for trade and quarantine purposes.

An excellent example of successful surveillance in South Africa is the soya bean rust (*Phakopsora pachyrhizi*) monitoring since the first incursion in 2001. As a result, the soya bean rust workshop was launched, and a task team was assembled to familiarise local researchers with the disease and develop a pre-emptive national soya bean rust strategy.

This success led to the emergency registration of fungicides and screening of the cultivars for resistance/tolerance. Surveillance of soya bean rust should continue, as reported in 2007, the kudzu vine (*Pueraria lobata*) was infected by the rust, providing a safe harbour for the pathogen, potential inoculum build-up and a green bridge for inoculum to spread.

Furthermore, the area under soya bean production is expected to expand and the potential use of fungicide applications could increase. Monitoring fungal populations for insensitivity against active ingredients over space and time can evaluate fungicide resistance build-up and data can be used to foster stewardship and responsible use of registered active ingredients.

Soya bean diseases

The top five diseases that account for global soya bean yield losses is the cyst nematode (*Heterodera glycines*), white mould (*Sclerotinia sclerotiorum*), soya bean rust, *Cercospora* leaf blight (*Cercospora kikuchii*) and brown spot (*Septoria lycopersici*; Savary *et al*., 2019). Although soya bean diseases such as white mould, or as we know it *Sclerotinia* stem and head rot, *Cercospora* leaf blight and *Septoria* brown spot have not been reported in sub-Saharan Africa according to Savary *et al*., they have been detected in South Africa. Most notably, the soya bean cyst nematode has not been reported in South Africa and is the most burdensome to soya bean yield globally.

The cysts on roots can release eggs into the soil and remain viable for years until they locate a susceptible host. The soya bean cyst nematode can only move a few millimetres in the soil; it can possibly be introduced to South Africa through human and informal seed movement and plant transplants. Authorised personnel at the borders can conduct a detailed risk assessment to identify potential sources and paths of cyst nematode entry. Regular surveillance at border checkpoints, ports and entry points to detect any indicators of cyst nematodes.

For diseases caused by *S. sclerotiorum*, which are regularly and widely reported, new host crops are often reported internationally, for example, blueberry in 2007, Argentina, Japanese plum, nectarine and sweet cherry in 2012 and 2013, Chile. Surveillance of *S. sclerotiorum* hosts is critical to ensure the pathogen's emergence on new hosts, and should this occur, timely management can be implemented.

Table 1: Contact details of diagnostic laboratories for plant pathogens in South Africa.

Institution	More information
DALLRD: Plant Health Diagnostic Services	*www.old.dalrrd.gov.za/Branches/Agricultural-Production-Health-Food-Safety/Plant-Health/Diagnostic-Services*
Agricultural Research Council: Plant Health and Protection	*www.arc.agric.za/arc-ppri/Documents/Services/PHP-Diagnostic%20 Services.pdf*
FABI Diagnostic Clinic	*www.fabinet.up.ac.za/index.php/special-projects/diagnostic-clinic*
Stellenbosch University: Plant Disease Clinic	*www.sun.ac.za/english/faculty/agri/plant-pathology/disease-clinic/ more-information/sample-collection-submission*

Conclusion

As citizens of South Africa, and more so as land users, we have a responsibility to report the suspected occurrence of pests and diseases in pest/disease-free areas. The Department of Agriculture, Land Reform and Rural Development (DALRRD) have early warning systems where reporting controlled pathogens of plant diseases, such as citrus greening and bacterial blight, caused by *Xanthomonas campestris* pv *punica*, can be made. To accurately report our findings, we need to be aware of characteristic symptoms and signs of controlled pests and diseases, as well as who to report them to.

Diagnostic laboratories for plant pathogens in South Africa include the DALLRD's Plant Health Diagnostic Services, Agricultural Research Council – Plant Health and Protection, FABI Diagnostic Clinic, and the Plant Disease Clinic at Stellenbosch University.

We need to keep using disease surveillance as a weapon against pathogenic invasions, to combat the enemy through readiness and understanding the tactics used by the enemy to enter, attack and advance.

For more information, contact Dr Lisa Rothman on 051 401 3666.

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Philagro's **EndoMaxx®** consists of a four system optimised beneficial mycorrhizae fungal species that form a symbiotic relationship with the root systems of sunflowers and other field crops (maize, soybeans, potatoes, dry beans, peanuts and peas), which improves the effectiveness of the roots. This improves yield potential.

Beneficial mycorrhizae fungi develop fungal threads (known as hyphae) that penetrate small soil spaces where the sunflower root volume does not normally develop. In this way the root system is effectively expanded.

BENEFITS

- Contributes to the optimalisation of a soil health strategy.
- Increases access to nutrients and water, as well as their uptake.
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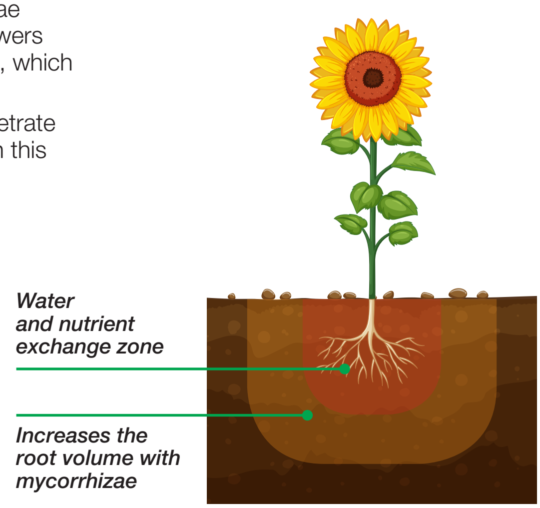

CONSULT THE PRODUCT LABEL FOR COMPREHENSIVE INSTRUCTIONS FOR USE AND RESTRICTIONS

EndoMaxx® ((Reg no. M200, Act 36 of 1947), contains Arbuscular Mycorrhizal Fungi (*Rhizophagus irregularis* (5 625 propagules / g), *Claroideoglomus luteum* (5 625 propagules / g), *Claroideoglomus claroideum* (5 625 propagules / g) , *Claroideoglomus etunicatum* (5 625 propagules / g). **EndoMaxx®** is a registered trademark of Mycorrhizal Applications LLC, Grants Pass, OR, VSA.

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Bayer (Pty) Ltd. Reg. No. 1968/011192/07. 27 Wrench Road, Isando, 1601. PO Box 143, Isando, 1600. **INTACTA RR2 PRO®** is a licensed product of **Bayer** AG, Germany.

A31666/Rev

Planting of soya bean refuge areas for effective insect control

The threat of insects developing resistance is a reality, but meticulous planning and management can lessen its impact. Developing and implementing an integrated resistance management programme is the best way of sustaining the benefits and insect protection that Bt technology offers.

Refuge areas are an integral element of an integrated resistance management programme for **INTACTA RR2 PRO®** crops. A refuge area is a block or strip of the same cultivar but which does not contain the Bt technology.

Retaining a population of insects that have not been exposed to the Bt protein is the main purpose of a refuge area. The lack of exposure to Bt proteins in the refuge area results in susceptible insects mating with resistant insects from the Bt crop.

This way, susceptibility to Bt technology is passed on to the offspring, helping to maintain the long-term effectiveness of this technology. The same refuge area strategy is effective against all targeted pests.

Planting a refuge area

For an area smaller than 400m, plant a refuge strip of at least six rows on one side of your **INTACTA RR2 PRO®** crops – a minimum of 20% of your land must be a refuge area.

For an area larger than 400m, plant strips of at least six rows every 800m on either side of the **INTACTA RR2 PRO®** crops – again, a minimum of 20% of the land must be a refuge area. In both instances, chemical control of bollworm is permitted in the refuge areas.

The refuge area must be planted along the borders of the field and within 400m of all **INTACTA RR2 PRO®** crops. The refuge cultivar must have the same growth length as the **INTACTA RR2 PRO®** cultivar. Encircling fields is also permissible, but the Bt and non-Bt rows may not intersect.

Mixing of Bt technology seed with seed that does not contain Bt technology must be avoided at all costs. The refuge area must be planted within seven days and grown under the same agronomic conditions as the **INTACTA RR2 PRO®** crops.

To avoid mixing of seeds during the planting process, remove all seeds from the seed trays when switching from Bt to non-Bt seed. Each producer is responsible for the refuge areas on his or her farm.

Seed companies need to complete integrated resistance management assessments during the growing season to ensure compliance as required by permit conditions. There must also be sufficient refuge seed for each season. It is in everyone's interest to ensure that these technologies are preserved; for this, producers need to co-operate fully when it comes to insect resistance management.

The continued availability of Bt technology depends on compliance with registration requirements as set out by the government. Having an effective integrated resistance management programme in place means producers can enjoy the advantages of effective and consistent insect protection, as well as improved yield potential when cultivating Bt technology crops.

Sustainable agriculture

INTACTA RR2 PRO® is highly compatible with the goals of integrated pest control and sustainable agriculture. Integrated pest control involves an effective and environmentally sustainable approach to insect management. Integrated pest control programmes utilise up-to-date, comprehensive information regarding the life cycle of pests in a way that has the least impact on people and the environment.

To enhance the sustainability of soya bean cultivation systems, producers need to follow the suggested integrated pest control practices (including cultural and biological control practices), conduct pest sampling, and incorporate pest threshold values for management practices in the correct manner.

These measures are not only essential for refuge areas, but are equally important for detecting and controlling non-target pests that cross the established threshold values on Bt crops.

Pest not controlled

INTACTA RR2 PRO® controls the main pest that threatens soya beans, namely the African bollworm, but will not control all insect pests on soya beans. Additional control measures may therefore be required where targeted or non-targeted insects cause serious infestation.

Fields should be scouted regularly, especially during periods of severe and persistent pest infestations. Refer to the integrated pest control monitoring guidelines to identify insects that require regular monitoring, as well as for suggested control strategies.

Management considerations

Employ the correct scouting techniques and treatment. Where possible, choose insecticides that have the smallest negative impact on beneficial insects. These insects can contribute to the control of other harmful insects. Rotate insecticides with different modes of action to reduce the risk of insect pests building up chemical resistance.

Use suggested tillage practices to prevent pests from overwintering in fields. Destroy crop residues directly after harvest and use appropriate control measures to reduce the overwintering of insects.

For more information on how to plant the correct refuge area for your soya beans, contact your nearest Bayer representative or visit *www.bayer.com*.

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Reg No. N-F 1516 (Namibia)
Patent No. 2014/06334

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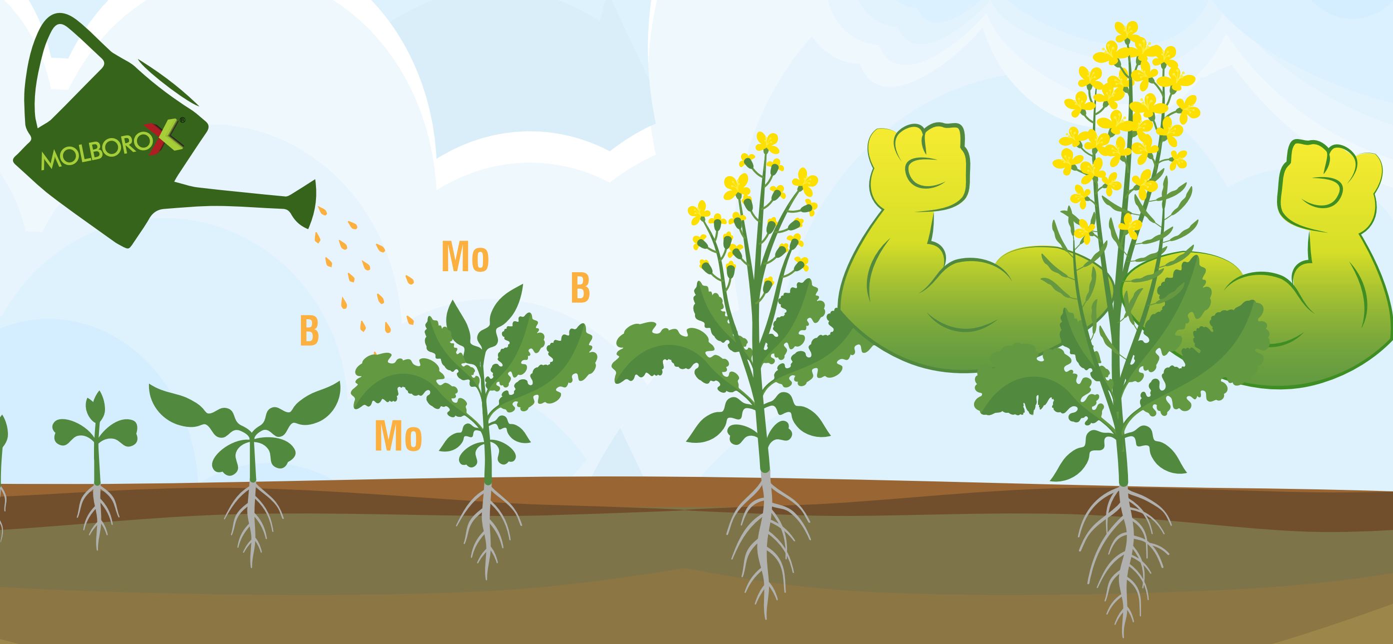
- **Molibdeen** (Mo) skakel stikstof om na aminosure en optimaliseer stikstofbinding
- **Boor** (B) beheer die translokasie van koolhidrate, bestuiwingsproses en wortelpunt vorming
- 1 L/ha bevat 100g B, 40g Mo, 6g Zn, 11g Mn, Seewier ekstrak, ouksien en sitokinien



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A guide to micronutrient management

Nutrient management is one of the important aspects of achieving higher crop yield and quality seed and oil. It is well known that macronutrients are essential to successful oilseed production. Still, certain micronutrients including iron (Fe), boron (B), zinc (Zn), manganese (Mn), molybdenum (Mo), cobalt (Cu) and copper (Co) are supplementary to boosting overall plant health and quality.

Each crop growth stage has a peak demand for different nutrients and uptake of some nutrients takes place at specific stages. Foliar nutrition is an effective way to ensure a steady supply of micronutrients, especially in conditions that are not favourable for the proper supply of nutrients through the root system.

The judicious application of micronutrients to align with the optimum/critical stage of nutrient uptake helps to use nutrients efficiently, address relevant abiotic/biotic stress conditions and ultimately to produce a good seed yield.

Seed germination and emergence

During this stage, the small seeds and relatively weak seedlings are very susceptible to poor seedbed conditions (e.g. compacted soil, weeds), unfavourable weather, pests and soilborne diseases. Since nutrient uptake is greater than crop growth, it is important to supplement with nutrients essential for germination and stimulating root growth.

Seed treatments containing Mn, Cu, Co and Zn applied during planting are an effective way to support growing seeds:

- Zn is vital in seed germination and early root development to promote the production of growth hormones (e.g. auxins) necessary for root elongation and establishment.
- Mn is involved in synthesising enzymes required to break down stored carbohydrates during seed germination.
- Co is involved in nitrogen fixation and contributes to the synthesis of vitamin B12, which is essential for the metabolism of oilseed crops.
- Cu is crucial during cell wall development, root elongation, the formation of lateral roots, and defence against pathogens.

Healthy development

Uneven canopy development can result in variations in light interception, nutrient uptake, and water utilisation among plants. Good plant structure ensures the efficient uptake of nutrients and enhanced mechanical stability which facilitates optimal light interception, and maximises photosynthesis and resistance to pathogens and pests.

During canopy and plant structure development, the following nutrients play a significant role:

- Fe is essential for the formation of chlorophyll, which is responsible for capturing light energy and converting it into chemical energy through photosynthesis.
- Mn is required for the synthesis of chlorophyll and supports various metabolic processes, including photosynthesis, respiration, and nitrogen metabolism.
- Zn is required for cell division, elongation and differentiation, which are essential for proper leaf and shoot growth.

Even flowering

Even flowering ensures that enough flowers are available for pollination, increasing the chances of successful fertilisation and seed development. Nutrient management during the flowering phase should include:

- B is essential for cell division and differentiation, pollen tube development and seed formation. It is involved in the synthesis of nucleic acids and proteins, contributing to proper seed development.
- Mo is required for nitrogen metabolism, as it is involved in the conversion of nitrate to ammonium within plants. It aids in the production of proteins and enzymes necessary for seed development.
- Co is involved in the regulation growth processes, including coleoptile elongation, leaf expansion and bud development. It also enhances the efficiency of other essential nutrients such as iron and phosphorus.

Management programme

Nutrico's crop nutrition programme can help you achieve excellent crop performance and maximise the yield and quality of all oilseed crops. Nutrico's comprehensive product portfolio (*Table 1*) offers a wide range of options to meet all oilseed fertiliser requirements.

Table 1: Nutrico product portfolio and application rate.

Product		Application rate	Physiological phase
STSA	Seed treatment is made available immediately after application. STSA replaces talc and graphite for planter lubrication and contains high levels of Zn, Mn, Co and Cu.	2,5g/kg seed	**Seed development**
nutrivo®	Phosphonate-based plant nutrients and biostimulant to promote optimal growth. Nutrivo® can be used with glyphosate products.	2ℓ/ha	**Canopy development**
MOLBOROX®	Liquid plant nutrients containing high levels of B and Mo.	1ℓ/ha	**Even flowering**

syngenta

Mitigating the impact of climate change on South Africa's agricultural industry

Climate change poses significant challenges to the global agricultural industry, with profound implications for growers. Christian Giesel, head of marketing at Syngenta South Africa, explains what the country's commercial growers can expect and the role Syngenta can play in assisting them to mitigate the impact of climate change on their businesses.

A survey of large-scale producers in the United States, France, China, Brazil, India and across Africa, carried out by Ipsos MORI* for the Syngenta Group in 2020, found that 72% have significant concerns regarding the impact climate change will have on crop yields, animal health and their ability to do business over the next five years. Three in four producers in Africa said their farming businesses have already been impacted a great deal by climate change, with droughts and water shortages cited as particular concerns.

Extreme weather conditions

Climate change has resulted in erratic rainfall patterns and water scarcity, making it challenging for producers to plan their operations effectively. Some regions experience reduced precipitation, leading to water scarcity and soil degradation. Irrigation becomes essential, but water resources are already strained. Efficient water management practices, along with innovative solutions, are crucial for producers to sustain agricultural productivity.

In South Africa, El Niño events bring prolonged periods of reduced rainfall, leading to severe droughts. This hampers crop growth and livestock farming, exacerbating the challenges already posed by climate change. El Niño disrupts planting and harvesting cycles, which impacts crop yields and economic stability in the agricultural sector.

South Africa has witnessed a steady increase in annual mean temperatures since 1979. According to *meteoblue.com*, the average temperature has risen by just more than one degree since then. Higher temperatures contribute to heat stress, reduced photosynthesis and lower crop productivity. Heatwaves become more frequent and intense, posing a threat to crop health and increasing the risk of wildfires. Growers face the need to adopt resilient crop varieties and implement effective irrigation strategies to cope with the changing climate.

> Syngenta is aware of the challenges climate change poses to the agricultural industry and is committed to providing solutions that assist producers in mitigating its effects.

The combination of decreasing rainfall, rising temperatures and the variability of both indicates climate change.

Syngenta's mitigation strategies

Syngenta is aware of the challenges climate change poses to the agricultural industry and is committed to providing solutions that assist producers in mitigating its effects. "Only through innovation in products, technology and services can we enhance water productivity, increase yield, reduce food loss and waste, and help sequester carbon in the soil," says Giesel.

Seed-treatment technology: Seed-treatment technology, such as fungicides, supports healthier root mass, which enhances carbon sequestration in the soil and improves crop yield.

Modern pesticides and traits: Syngenta's advanced pesticides and new traits protect crops from weeds, insects and diseases, making them more resilient to extreme weather conditions. This increases land productivity and reduces greenhouse gas emissions from avoided land conversion.

Regenerative management practices: Syngenta promotes climate-smart practices, including minimum tillage, crop rotation and effective nutrient management. These practices, when combined with permanent crop cover strategies, turn agricultural fields into carbon sinks that remove carbon dioxide from the atmosphere.

Technology: Producers have been using machinery and GPS technology for decades to maximise their yield. "Breakthroughs in artificial intelligence and machine learning are already boosting agricultural innovation. These innovations are becoming more relevant than ever in precision farming and Syngenta is at the forefront of this trend," explains Giesel. Examples of such innovations include Syngenta's RiskMap and Spray Assist tools.

The RiskMap is Syngenta's online disease-risk service that provides potato growers with a free resource that removes a lot of uncertainty from the crop-protection decision-making process, thus helping growers to improve yield, crop quality and profitability.

The CropWise Spray Assist application further assists growers by recommending when to spray based on the near-term weather forecast and which nozzle to use. Forecasting is done up to five days ahead and to the nearest hour for the most efficient application of products.

Syngenta believes a synergistic approach is key to managing climate change. "We need collaboration between stakeholders, including Syngenta, policymakers and growers, to build a sustainable and climate-resilient agricultural sector in South Africa," concludes Giesel.

For more information, contact Syngenta on 011 541 4000 or visit *www.syngenta.co.za*.

Turning crop biochemicals into bioherbicides

By Prof Charlie Reinhardt, North-West University

Flowering plants are unique amongst the higher living organisms in that they cannot escape danger by fleeing from threats; roots firmly anchor them in the ground. Therefore, it stands to reason that nature endowed them with formidable chemical arsenals for protection against biological threats such as herbivores, microbes and competing plants. Just one such chemical defence capability is employed by plants in the competition battle with other plants for essential growth resources such as light, nutrients and water.

'Allelopathy' is the name of the phenomenon in which a plant exerts a harmful effect on another through the production and release into the environment of germination- and growth-inhibiting biochemicals called 'allelochemicals'. The term 'allelopathy' derives from the Greek prefix *allelo*, meaning 'mutual' or 'reciprocal, and the Greek word *pathós*, meaning 'suffering'.

The autumn and winter weed, Senecio consanguineous (starvation senecio; radiator-bossie), on a sunflower field – a common sight in the summer rainfall region. Note that there are significantly fewer weed plants growing on and close to the crop rows – probably the result of allelopathy and competition that leads to interference exerted by the sunflower crop.

Both crop and weed species possess allelopathic potential, but in terms of the potency of their chemical arsenal, some are more gifted than others. The phenomena of allelopathy and competition operate together in nature wherever plants of the same or different species grow close together, such as crop and weed plants in crop production systems.

Allelochemicals typically have their strongest effects at the germination and seedling establishment growth stages, whereas competition only kicks in later when plants start to compete for limited resources of light, water and/or nutrients. Together, allelopathy plus competition explains the overarching plant-to-plant interference phenomenon.

Allelochemical applications

Finding practical applications for allelochemicals for the sake of economic gain has not been neglected by researchers in the agrochemical industry. A notable success story is the one where the allelopathic potency of certain rice cultivars was enhanced in the 1990s through classical breeding programmes of the International Rice Research Institute, the aim being to become less dependent on synthetic herbicides for weed control. This innovation apparently works well in paddy rice where the allelochemicals released from rice plants dissipate in a water medium for the control of grass weeds.

Another somewhat different economic success emanating from allelochemicals culminated in the development of one of the top-selling synthetic herbicides globally, namely mesotrione herbicide (the active ingredient in products such as Callisto and Cantron). This story started

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villa

with the discovery of the allelochemical leptospermone in the bottlebrush tree (*Callistemon australis*) and, subsequently, the manipulation of the molecular structure of this natural compound in the laboratory to turn it into mesotrione, a synthetic (factory-produced) herbicide.

Harnessing sunflower allelopathy

Sunflower (*Helianthus annuus*) belongs to the plant family *Asteraceae* (aster, daisy or sunflower family), which also includes numerous weedy species, many of them with strong allelopathic potential. The allelopathic potential of sunflower was reported in the 1980s and numerous studies have since demonstrated that certain cultivars have greater allelopathic potency than others, i.e., allelochemicals in sunflower plants vary in type, concentration, and potency or phytotoxicity between cultivars.

Above-ground parts of sunflowers are rich in compounds belonging to different classes of biochemicals, especially terpenoids, but also phenolics, flavonoids and coumarins. These compounds are referred to as secondary metabolites because they do not participate in the key life processes, but often serve as specialist defence chemicals providing protection against threats posed by biological and environmental (climate) factors.

For almost three decades now sunflower cultivars have yielded a constant stream of unique biochemicals, many of which show allelopathic potential. This year again, seven hitherto undescribed compounds, in addition to 18 known compounds, were isolated from flower heads of a sunflower cultivar (J Bai *et al*., 2023, *Phytochemistry*, volume 211).

The chemical value of sunflower is not restricted to its allelochemicals; Chinese folklore claims several cures for human ailments based on the use of all parts of the sunflower plant. The medicinal value of the head of the sunflower is prominently recorded in the *Shanghai Standard of Traditional Medicine* for the treatment of headaches, dizziness, toothache, stomach cramps, etc.

Weed suppression ability

Earlier it was explained how mesotrione herbicide was derived from its natural precursor molecule, leptospermone, an allelochemical compound that belongs to the sesquiterpene lactone class of biochemicals. Research in the 1990s revealed that a single sunflower cultivar yielded 13 types of sesquiterpene lactones, four of which were newly discovered (FA Macias *et al*., 1996, *Phytochemistry*, 43: 1 205-1 215).

In laboratory testing, these authors found that one of these compounds showed a significantly greater phytotoxic effect on the test plant compared to a highly potent commercial herbicide product, but this phytotoxic effect was lost within hours when natural soil was the growth medium instead of an artificial medium. Soil microbes use allelochemicals as food, and therefore rapid degradation or inactivation in the soil is the typical fate of biochemicals (allelochemicals) upon their release from plants.

The practical value of sunflower plants performing their own weed control is attributed to the release of allelochemicals with phytotoxic or bioherbicidal activity from both live plants and plant litter. The chemical diversity of allelopathic compounds released from these plant materials is vast, and hence conducting field research on the chemistry dynamics alone is complex; microbial action, which constantly creates new chemicals, exacerbates the research challenge. Fortunately, producers only need to bear in mind that sunflowers can suppress weeds by biochemical means while the crop is growing, as well as after death when sunflower litter can do the same.

By recognising that the dosage of allelochemicals, and hence allelopathic (phytotoxic) potency, is directly related to plant biomass, it stands to reason that weed suppression can be increased by increasing sunflower biomass (alive or dead) per unit area of land; higher crop density and higher amounts of crop litter are likely to enhance weed suppression. Already in the early 1990s, on sunflower fields in the state of Arkansas in the United States, it was a popular practice to concentrate crop litter in windrows at the end of the season and to establish the following crop (e.g., maize) by direct drilling into the sunflower residue.

Canola allelopathy

Is it just imagination playing tricks on the observer who notices fewer weeds on a field planted to canola compared to the same field under wheat? Likely there really is better suppression of weeds in the canola compared to wheat. But then, it must be recognised that canola as well as certain cereal crops (small grains such as rice, wheat, oats, etc.) are well known for their production and release of allelochemicals that can suppress weeds (Ferreira and Reinhardt, 2010).

Canola or oilseed rape (*Brassica napus*) belongs to the plant family *Brassicaceae* (mustard family) and originated from hybridisation between wild cauliflower (*Brassica oleracea*) and wild turnip (*Brassica rapa*). Brassica plants are well known for their use as cover crops for controlling weeds, fungi, nematodes and insects. Such crop-beneficial effects are due to the toxicity of primarily isothiocyanate compounds produced by and released from brassica species during active growth and after plants have died off.

Canola varieties differ in their allelopathic potential and probably also in their efficacy to control fungi, nematodes and insects. Mulch produced from a mixture of canola and wild turnip contributed high amounts of isothiocyanates to soil where these compounds inhibited the germination of several serious weed species (J Petersen *et al*., 2001).

The dose makes the poison

The age-old toxicology maxim "All things are poison, and nothing is without poison; the dosage alone makes it either a poison or a remedy" is credited to Paracelsus (1538). Cover crop and organic mulch practitioners are advised to bear this timeless truth in mind – the allelopathic potential of plants (alive or dead) is directly related to the dosage of allelochemicals, which equates to the biomass of plant material.

Above certain critical biomass of cover crops or mulch, there could be harmful allelopathic effects on the crop that is supposed to benefit from the practice.

Charlie Reinhardt is a professor in agronomy at North-West University, and research project lead of the South African Herbicide Resistance Initiative (SAHRI) at the University of Pretoria. For more information and references, contact him at 083 442 3427 or dr.charlie.reinhardt@gmail.com.

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Optimal nitrogen supply to soya beans

By Nadine Loubser, R&D microbiologist, and Jonathan Etherington, director, MBFi

Soya bean is an important crop and is commonly used for food and feed sources. Since soya beans are one of the most economical crops, improved production is important without the expense of environmental pollution.

Nitrogen can only be supplied to soya beans using organic matter, synthetic fertilisers, or biological nitrogen fixation. It is generally recommended that 70 to 105kg of nitrogen be applied to soya beans to yield one ton. However, if synthetic nitrogen sources such as urea and ammonium nitrate are used, a huge volume is required and the environmental implications of using these nitrogen sources can be catastrophic.

Biological nitrogen fixation

Studies done in the United States (US) showed that 50 to 82% of synthetic fertilisers are lost in the atmosphere or in surface or groundwater. Synthetic fertilisers negatively impact air and downstream water quality. Therefore, the use of *Bradyrhizobium japonicum* or *Bradyrhizobium elkanii* is required to provide the nitrogen the plant needs by means of biological nitrogen fixation.

Nodules on soya beans.

For biological nitrogen fixation to take place, the bacteria (known as *Bradyrhizobium*) need to form a mutualistic relationship with the plant. This implies that both partners in the relationship benefit from the relationship. The bacteria provide the plant with nitrogen and the plant provides the bacteria with a carbon source and shelter for survival.

The first step in biological nitrogen fixation is communication that takes place between the plant and the bacteria. The communication between the plant and bacteria is specific. Flavonoids are produced by the plant root and bind to receptors on the plasma membrane of rhizobia. The binding causes the activation of the nod (nodulation) gene. This leads to the production of nod factors or NFs that bind to receptors of plant root hair cells.

Thereafter, rhizobia attach to the plant within five minutes. Attachment occurs by different means depending on whether the soil is acidic or alkaline. Thereafter, the root hair will curl to entrap the bacteria. Bacteria enter the root hair by means of an infection thread and penetrate root cortex cells. The root cortex cells will divide, and the bacteria will differentiate and develop into bacteroids.

Finally, vascular tissue will develop and allow nitrogen to be transported to the plant and sugar to be transported to the bacteria. In the nodule, rhizobia will convert atmospheric nitrogen into ammonia, which is in a usable form for the plant.

Influencing factors

There are a few factors that influence the process of nitrogen fixation in plants. By adding large amounts of additional nitrogen to soils, together with the nitrogen-fixing bacteria, it can lead to suboptimal or no nodulation. Furthermore, abiotic conditions contribute to unfavourable nodulation or no nodules forming at all.

These abiotic stressors include drought, water-logged soils, extreme temperatures, salinity, and acidity. It is therefore important to select and use products containing more resilient bacteria to withstand these unfavourable conditions for longer time frames. For example, rhizobia with osmotolerance capabilities can survive better in the environment compared to other rhizobia that do not have these capabilities. Plant breeders can genetically modify soya bean varieties to withstand these unfavourable conditions better.

There are also a few other factors that contribute to successful biological nitrogen fixation, and these are related to product quality. The shelflife, purity, and on-seed survival of the isolate used in the product also contribute towards successful nitrogen fixation. There are a few nutrients that contribute towards successful nodulation which include phosphate, sulphur, molybdenum, cobalt, and iron.

By using nitrogen-fixing bacteria, the process is more dependent on favourable environmental conditions than with the addition of synthetic fertilisers. However, there is no negative impact on the environment when using inoculants containing *Bradyrhizobium*. Optimal nitrogen fixation can be achieved by maintaining good soil health, using the correct inoculant required for the biological nitrogen fixation to take place, and providing the plant with the nutrients required.

For more information, visit *www.mbfi.co.za* or call 082 738 0080.

Hammermill screen selection for soya bean processing:

Effects of soya bean meal particle size on amino acid digestibility, feed milling efficiency and D1-42 broiler performance

By AM Lyons, CM Poholsky, LS Erb, PH Patterson and JW Boney

Maize particle size (PS) affects feed milling parameters, amino acid (AA) digestibility and broiler performance. However, there is limited work on soya bean meal (SBM) PS. Three experiments were conducted to determine the effects of SBM PS on d21 apparent ideal AA digestibility (AIAAD), feed milling efficiency, pellet quality (PQ) and d1 to 42 broiler performance.

A hammermill fitted with one of three screens (2,4mm, 5,6mm, 7,9mm) was used to process the SBM used in all experiments. In experiment 1, an indigestible marker, titanium dioxide, was added to the diet and its concentration in digesta was used to calculate AIAAD.

D21 AIAAD was influenced by SBM PS where fine SBM (2,4mm screen) reduced AA digestibility for all AA compared to other treatments ($P < 0,05$). In experiment 2, SBM PS did not affect hot pellet temperature or production rate ($P > 0,05$). However, PQ improvements were apparent when the fine SBM was used ($P < 0,05$).

In experiment 3, SBM PS impacted broiler performance in all feeding phases ($P < 0,05$). Overall (d1 to 42) FI, BWG and FCR increased when fine SBM was fed compared to when medium (5,6mm screen) and coarse (7,9mm screen) SBM was fed ($P < 0,05$). Finally, SBM PS did not affect gizzard size ($P > 0,05$). These experiments suggest that although finely ground SBM improves PQ between 5 and 8%, the fine SBM PS reduces AIAAD and worsens broiler FCR.

Problem investigation

Feed ingredients and feed manufacturing represent considerable costs to an integrated broiler operation. Within these costs, ingredient particle size (PS) reduction is the second largest expenditure after pelleting (Reece *et al*., 1985). Generally, the cost of grinding feed ingredients increases as the desired PS of the ingredient decreases (Reece *et al*., 1986; Wondra *et al*., 1995).

Lyons *et al*. (2022) demonstrated that reducing the hammermill screen size from 7,9 to 5,6mm and 2,4mm increased energy consumption by 0,72kW/ton and 1,67kW/ton, respectively. Coarse grinding of ingredients can reduce costs associated with milling. Despite this, the relationship between ingredient PS and bird performance should be considered before using feed production methods that reduce production costs.

Ingredient PS has been reported to impact various aspects of poultry production, including digestive tract development, feed passage rate, nutrient digestibility and bird performance (Gabriel *et al*., 2003; Amerah *et al*., 2007; Lyu *et al*., 2021; Marx *et al*., 2021). These PS effects are more prominent in mash diets compared to pelleted diets (Amerah *et al*., 2007). However, ingredient PS can impact bird performance after pelleting (Peron *et al*., 2005; Lentle *et al*., 2006).

Pellet quality (PQ) may also be influenced by ingredient PS. Improvements in pellet durability when maize PS was reduced have been reported (Wondra *et al*., 1995; Chewning *et al*., 2012), and are known to improve BW and FCR in broilers (McKinney and Teeter 2004; Corzo *et al*., 2011; Lilly *et al*., 2011; Glover *et al*., 2016). Although, the PS of feed ingredients for optimal pelleting efficiency is unclear.

A majority of PS research has focussed on cereal grains, while only a few researchers have studied the PS of

Table 1: Analysed nutrient values and particle size of diets fed to Ross x Ross 708 male broilers from d11 to 21 (experiment 1).

SBM particle size	Crude protein[1] (%)	Crude fat[2] (%)	Crude fibre[3] (%)	Ash[4] (%)	Moisture[5] (%)	Gross energy[6] (kcal/kg)	Particle size[7] (µm)
Fine	20,38	6,08	3,10	5,80	9,38	4,123	571,11 ± 2,22
Medium	20,31	6,35	3,70	5,90	9,05	4,145	602,77 ± 2,36
Coarse	20,75	5,92	3,10	6,42	9,66	4,123	668,85 ± 2,38

[1]Crude protein determined using AOAC 992,15; AOAC 990,03; AOCS Ba 4e-93. [2]Crude fat determined using AOAC 920,39. [3]Crude fibre determined using AOAC 962,09; AOCS Ba 6-84. [4]Ash determined using AOAC 942,05. [5]Moisture determined using AOAC 930,15. [6]Gross energy was analysed using a Parr 6200 isoperibol bomb calorimeter (Parr Instrument Co, Moline, IL). [7]Particle size determined using ASAE S319,4. The means presented are the average of duplicate samples ± SD.

soya bean meal (SBM). Considering the importance of ingredient PS on both feed and poultry production, three experiments were conducted to determine the effects of SBM PS on apparent ileal amino acid digestibility (AIAAD), feed milling efficiency, PQ parameters, and d1 to 42 broiler performance.

Experiment 1: Apparent ileal amino acid digestibility

Particle size analysis: Results from the PS analysis of the diets are located in *Table 1*. The diet containing fine (2,4mm) SBM generally had a smaller PS compared to the diets with medium (5,6mm) and coarse (7,9mm) SBM. The largest difference in PS (97µm) was between diets containing either fine or coarse SBM.

Indispensable amino acid digestibility: Hammermill screen size and resulting SBM PS influenced the digestibility of all indispensable AA. The diet containing fine SBM had the lowest digestibility coefficient for all indispensable AA (P < 0,05).

Dispensable amino acid digestibility: All dispensable AA followed a pattern similar to that of the indispensable AA with the fine SBM having the lowest digestibility coefficients (P < 0,05). The coarse SBM consistently had the highest digestibility coefficient, except for proline and alanine where digestibility was similar to the medium SBM. Coarse SBM inclusion improved cysteine digestibility by 10,39% compared to fine SBM (P < 0,001).

Increased retention time in the gizzard and intestines increases exposure time with digestive enzymes, resulting in improved nutrient digestibility (Xu *et al*., 2015).

Experiment 2: Feed milling efficiency and pellet quality

Feed milling efficiency: Neither HPT nor production rate was affected by SBM PS (P > 0,05). The subtle changes to diet PS were not expected to affect HPT or production rate. Similarly, Martin (1985) found no differences in feed mill production rate when poultry diets were pelleted with maize or sorghum passed through 3,2 or 6,4mm hammermill screens (P > 0,05).

Although no measurable differences in production rate were observed in the current experiment, feed flowability at the mill was poor when pelleting diets were made with fine SBM. The diet containing fine SBM slowed feed transport from the mixer to the surge bin above the pellet mill. In addition, the fine SBM diet plugged the pellet die during each of the manufacturing runs. This required feed manufacturing to halt and ultimately reduced throughput. Unfortunately, this was not measurable but should be considered when selecting SBM PS.

Pellet quality analyses: Fine SBM improved pellet durability (P < 0,05), likely attributed to an increase in surface area with fine particles, allowing better agglomeration and binding of the pellet (Corzo *et al*., 2011). When considering pellets made with 0,5% mixer added fat, fine SBM improved PDI and MPDI while coarse SBM decreased pellet durability (P < 0,05). Diets containing medium SBM were intermediate in PDI and MPDI.

Experiment 3: Broiler performance

Soya bean meal PS influenced broiler performance throughout all three feeding phases (*Table 3*). Birds consuming feed with fine SBM consumed more feed in all three feeding phases compared to other treatments (P < 0,05). The analysed crude protein and gross energy of the starter diet were lower for the fine SBM treatment compared to the medium and coarse SBM treatments (*Table 2*).

It is possible that a feed sampling error occurred. Mash feed was mixed before pelleting and these mash feed nutrient values closely align with the diet formulation and other starter period treatments. Regardless, FI was only 20g per bird less when comparing the fine SBM and medium SBM treatments during the starter phase.

The magnitude of FI differences increases in the grower and finisher phases where analysed nutrient values were similar across dietary treatments. In the grower and finisher phases, BWG was highest for birds fed diets with fine SBM (P < 0,05). Feed conversion ratio was improved for birds fed the diets containing medium and coarse SBM in the starter and finisher phases (P < 0,05).

Overall (d1 to 42), SBM PS influenced all performance parameters (*Table 3*). Broilers consuming diets with fine SBM increased FI by 463g/bird compared to those fed

Table 2: Analysed nutrient values of diets fed to Hubbard x Ross 708 male broilers from d1 to 42 (experiment 3).

Diet phase	SBM particle size	Crude protein[1] (%)	Crude fat[2] (%)	Crude fibre[3] (%)	Ash[4] (%)	Moisture[5] (%)	Gross energy[6] (kcal/kg)
Starter (d1 to 14)	Fine	18,38	6,04	2,65	5,24	12,33	3,990
	Medium	22,69	6,49	2,50	5,88	12,47	4,101
	Coarse	23,06	6,29	2,50	5,45	12,47	4,079
Grower (d15 to 28)	Fine	21,25	7,87	2,30	4,97	13,84	4,167
	Medium	23,38	7,82	2,50	4,73	11,90	4,233
	Coarse	21,94	7,71	2,20	4,86	12,61	4,145
Finisher (d29 to 42)	Fine	19,75	8,48	2,20	4,93	12,45	4,167
	Medium	19,75	7,89	2,30	4,92	12,28	4,145
	Coarse	19,56	8,31	2,20	4,60	12,24	4,189

[1]Crude protein determined using AOAC 992,15; AOAC 990,03; AOCS Ba 4e-93. [2]Crude fat determined using AOAC 920,39. [3]Crude fibre determined using AOAC 962,09; AOCS Ba 6-84. [4]Ash determined using AOAC 942,05. [5]Moisture determined using AOAC 930,15. [6]Gross energy was analysed using a Parr 6200 isoperibol bomb calorimeter (Parr Instrument Co., Moline, IL).


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Table 3: Effects of soya bean meal particle size on Hubbard x Ross 708 male broiler performance from d1 to 42 (experiment 3).

	Starter (d1 to 14)			Grower (d15 to 28)			Finisher (d29 to 42)			Overall (d1 to 42)			Gizzard (d42)	
SBM particle size	**FI (kg/bd)**	**BWG (kg/bd)**	**FCR[1] (kg: kg)**	**FI (kg/bd)**	**BWG (kg/bd)**	**FCR (kg:kg)**	**FI (kg/bd)**	**BWG (kg/bd)**	**FCR (kg: kg)**	**FI (kg/bd)**	**BWG (kg/bd)**	**FCR (kg: kg)**	**Weight (g)**	**Yield (%)**
Fine	0,474^{a}	0,352	1,389^{a}	1,550^{a}	1,103^{a}	1,409^{b}	2,647^{a}	1,565^{a}	1,692^{a}	4,700^{a}	3,038^{a}	1,547^{a}	31,8	1,06
Medium	0,454^{b}	0,362	1,256^{b}	1,175^{c}	0,814^{c}	1,473^{a}	2,401^{b}	1,479^{b}	1,624^{b}	4,107^{b}	2,697^{c}	1,523^{b}	29,6	1,11
Coarse	0,464^{ab}	0,374	1,241^{b}	1,286^{b}	0,886^{b}	1,466^{a}	2,417^{b}	1,477^{b}	1,637^{b}	4,237^{b}	2,784^{b}	1,522^{b}	30,0	1,10
P-value	0,003	0,317	0,046	0,001	0,001	0,001	0,001	0,002	0,001	0,001	0,001	0,002	0,193	0,660
LSD	0,011	0,030	0,127	0,059	0,048	0,027	0,071	0,040	0,027	0,131	0,086	0,012	2,6	0,10
SEM	0,004	0,010	0,043	0,020	0,016	0,009	0,024	0,014	0,009	0,045	0,029	0,004	0,9	0,04

$^{a-c}$ Means within a column with different superscripts differ (P < 0,05). [1]Mortality corrected FCR: mcFCR = FI/(LWG + Wt of mortality).

diets with coarse SBM (P < 0,001). Feed intake may have been influenced by the reduced AA digestibility, as explained in experiment 1.

Further, steam conditioning and pelleting are known to impact nutrient digestibility. Barua *et al*. (2020) reported that broilers consuming pelleted diets had reduced AA digestibility for all dispensable AA compared to birds consuming mash diets (P < 0,05). Perhaps, the increased surface area of feed with fine SBM PS exposed the proteins to harsh temperatures during steam conditioning, further reducing AA digestibility.

To compensate and meet their AA requirements, broilers increased their FI. This speculation is further supported by Glover *et al*. (2016) where similar, marginal improvements to the percentage of pellets in the finisher phase had no impact on broiler FI.

In the current experiment, broilers consuming feed made with fine SBM had increased BWG by 254g/bird compared to those fed diets containing coarse SBM (P < 0,001). Although BWG was greater for birds consuming the fine SBM diet, they converted feed to gain less efficiently, which is reflected in the FCR. Birds consuming diets containing coarse SBM demonstrated a 0,025 improvement in FCR compared to those fed diets containing fine SBM (P = 0,002).

Abdollahi *et al*. (2018) suggested that pelleted diets may increase the passage rate of feed and when paired with an increase in FI, nutrient digestibility may be compromised. Similar to the current experiment, Amerah *et al*. (2008) found that broilers consuming a pelleted diet with fine cereal grains demonstrated higher FI (P < 0,05), whereas birds consuming a diet with coarse cereal grains consumed less feed and exhibited a 0,074 FCR improvement. Xu *et al*. (2015) reported significant improvements in FCR when birds were fed a pelleted diet containing 50% coarse maize relative to a 0% inclusion; however, FI was not different (P > 0,05).

Feed conversion ratio improvements may be associated with increased retention time in response to the coarse particles, leading to improved nutrient digestibility. Overall, when provided in a pelleted diet, medium and coarse SBM improve feed efficiency.

Gizzard weights: Neither gizzard weight nor yield was influenced by SBM PS (*Table 3*; P > 0,05). Previous work indicates that maize PS has a greater effect on gizzard weight than SBM or wheat (Amerah *et al*., 2008; Pacheco *et al*., 2013). The PS of feed ingredients is reduced during conditioning and pelleting. Higher proportions of pelleted feed particles occur on sieves with smaller openings when compared to mash feed particles.

This significant level of grinding and particle distribution resulted in a smaller post-pellet PS for dietary treatments containing medium and coarse SBM. Therefore, similar gizzard weights and yields were expected.

Conclusions and applications

Finely ground SBM (2,4mm hammermill screen size) reduced AIAAD. Fine SBM inclusion improved pellet durability, feed intake and weight gain but reduced feed flow and plugged the pellet die in all three feed manufacturing replicates.

In addition, including fine SBM in pelleted diets worsened FCR, likely associated with further reduction in AIAAD from the pelleting process. Using either the 5,6 or 7,9mm hammermill screen to grind SBM improved the FCR of broilers fed a pelleted diet from d1 to 42.

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To read the full paper, visit *www.sciencedirect.com/science/article/pii/S1056617122000861*.

The advantages of twin-screw extrusion

By Prof LJ Grobler, director of CFAM Technologies and professor in mechanical engineering, North-West University, Potchefstroom

Known for their rich protein content, essential amino acids and energy-dense composition, soya beans are a preferred ingredient in livestock diets. Processed into soya bean meal, this versatile byproduct offers exceptional digestibility and cost-effectiveness, and promotes optimal growth and health in various animal species, including poultry, pigs and cattle. Its widespread use underscores soya beans' significance in supporting sustainable and efficient animal production systems.

Soya beans are included in animal feed for the following reasons:

- ***High protein content:*** Soya beans are an excellent source of high-quality protein, containing all the essential amino acids necessary for animal growth and development. Both are valuable ingredients in animal feed formulations.
- ***Nutritional profile:*** Soya beans are rich in essential nutrients, including carbohydrates, fats, vitamins (such as vitamin E, riboflavin and folate) and minerals (such as calcium, iron and zinc). These nutrients contribute to the nutritional balance of animal feed and support various physiological functions.
- ***Cost-effectiveness:*** Soya beans are widely cultivated and have a relatively low cost compared to some other protein sources.
- ***Availability:*** Soya beans are globally produced and traded, ensuring a consistent and reliable supply for animal feed manufacturers.
- ***Sustainability:*** Soya beans have a favourable environmental profile compared to some other protein sources. They have a relatively low land and water footprint, and contribute to the efficient use of agricultural resources. Soya bean cultivation can be more sustainable when managed through responsible agricultural practices.
- ***Functional properties:*** Soya beans and soya products possess functional properties that can enhance the texture, binding capacity and stability of animal feed. These properties contribute to the overall quality of the feed and help ensure proper handling and processing during feed manufacturing.

While it is acknowledged that soya beans should undergo heat treatment before animal consumption, certain producers continue to feed raw soya beans to their livestock. In addition, it is common to find sheep grazing in soya bean fields after harvest.

However, feeding animals raw soya beans, without having processed it, can lead to several consequences because of the following:

Anti-nutritional factors: Raw soya beans contain anti-nutritional factors that can interfere with digestion and nutrient absorption. These include trypsin inhibitors, phytic acid, lectins and allergenic proteins. These compounds can reduce the digestibility of nutrients and may lead to decreased feed efficiency and performance in animals.

Digestibility issues: The presence of certain enzyme inhibitors, such as urease, in raw soya beans can hinder the breakdown of proteins and other nutrients, making them less available for absorption.

Poor palatability: Raw soya beans have a bitter taste and unpleasant odour, which can make them unappealing to animals, resulting in reduced feed intake and potentially reduced growth and performance.

The CFAM TX 50 Twin-screw extruder.

Digestive disorders: Consumption of raw soya beans in large quantities can lead to digestive disorders in animals. The anti-nutritional factors present in raw soya beans can cause gastrointestinal disturbances including diarrhoea, flatulence and bloating.

Nutrient imbalance: Raw soya beans have a different nutritional profile compared to processed soya bean products. Their crude protein, fat and carbohydrate content can vary, leading to potential nutrient imbalances if not properly formulated.

Potential toxicity: Raw soya beans contain certain compounds that, when consumed in large amounts, can be toxic. For example, soya beans contain small quantities of naturally occurring toxins called isoflavones. Although the levels of these compounds are usually not harmful, high intakes can have estrogenic effects or disrupt normal hormonal balance.

Many of these negative aspects can be mitigated by appropriate heat processing techniques such as extrusion (which is commonly used). By extruding full-fat soya beans, the nutritional quality, digestibility, palatability and safety of the soya beans are improved, resulting in enhanced animal performance and overall feed efficiency.

Single- and double-screw extruders

It is generally accepted that single-screw extruders are suitable for processing full-fat soya beans. Single-screw extruders primarily rely on friction, whereas twin-screw extruders function akin to a positive displacement pump. Various factors, including feed rate, feed uniformity, material properties, maintenance and wear, have a greater influence on the performance of single-screw extruders compared to twin-screw extruders. These variable factors lead to greater variations in extruded product outputs when single-screw extruders are employed.

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Extruded full-fat soya meal.

Twin screw extruders can effectively rupture oil cells and lipid bodies in soya beans, facilitating the extraction of oil and other components. This is because of the combination of mechanical shear, heat and pressure to rupture the cells and break down the structure of the soya beans. These factors can be varied but also controlled by changing the screw elements die plates and varying operating parameters such as screw speed, feed rate, temperature set points and even water addition into the barrel.

Higher cooking temperatures improve amino acid digestibility and reduce trypsin inhibitor activity. To prevent or minimise the Maillard reaction it is important to keep the cooking temperature below the critical temperature at which Maillard occurs.

Amino acid digestibility

For higher amino acid digestibility, apply heat to denature proteins and disrupt the cell structure, making the amino acids more accessible for digestion. The appropriate temperature range for achieving this ranges between 90 and 130°C. However, since twin-screw extrusion is more stable with more accurate temperature control, you can comfortably operate around 130°C.

Trypsin inhibitors and urease

Soya beans contain trypsin inhibitors. These inhibitors can interfere with the activity of trypsin, an enzyme involved in protein digestion. The levels of trypsin inhibitors in soya beans can vary depending on factors such as cultivar, processing methods and environmental conditions. Proper processing methods such as heat treatment or fermentation can help reduce trypsin inhibitor levels, improving the digestibility and nutritional value.

Soya beans contain urease, an enzyme that can hydrolyse urea into ammonia and carbon dioxide. High levels of urease can lead to undesirable effects when used as animal feed. If consumed without proper processing, urease can increase the pH in the digestive system, disrupt protein digestion and potentially cause ammonia toxicity. Heat treatment or other processing methods are necessary to inactivate urease and mitigate its negative impact on health and digestion.

Maillard reaction

The Maillard reaction is a complex chemical reaction that occurs between amino acids and reducing sugars under conditions of heat. It is responsible for the browning, flavour and aroma development in cooked or processed food and feed.

While the Maillard reaction can enhance the sensory attributes of food, excessive or prolonged heat exposure can lead to the formation of potentially harmful compounds, such as acrylamide or advanced glycation end products (AGEs). Proper cooking techniques and control of cooking conditions are important to balance flavours and minimise the formation of undesirable compounds.

The Maillard reaction accelerates significantly above 140°C so stay below 140°C and ensure that the surface temperatures of the extruder barrel do not increase above this. This is where twin-screw extruders with the ability to cool their barrels have an advantage.

Using twin-screw extrusion instead of single-screw extrusion allows you to operate closer to the Maillard threshold temperature, thus providing the highest amino acid digestibility. This is the main reason why twin-screw extrusion is becoming more popular in the extrusion of full-fat soya beans.

Twin-screw extrusion has the following advantages:

- ***Restart after load shedding:*** Twin-screw extruders can restart without the need to open the die, barrel and screws after load shedding if the backup power comes on within three minutes. Only twin-screw extruders with advanced automation systems can restart after load shedding.
- ***Increased capacity:*** Twin-screw extruders have a higher production capacity compared to single-screw extruders. They can process larger volumes of food materials in a shorter time, making them more suitable for large-scale production.
- ***Better mixing and uniform heating:*** Twin-screw extruders provide better mixing of ingredients due to the co-rotating screws. This ensures a homogeneous blend of food materials, resulting in improved product quality. The twin screws provide better heat transfer, leading to more uniform heating throughout the extruder, which is important for achieving consistent cooking or processing of the food.
- ***Multiple processing zones:*** Twin-screw extruders offer multiple processing zones along the length of the extruder. Each zone can be independently controlled for temperature, pressure and shear, allowing for precise control over the processing parameters.
- ***Versatility:*** Twin-screw extruders can handle a wider variety of food materials compared to single-screw extruders. They can process both dry and wet ingredients and can handle ingredients with different viscosities and textures.
- ***Enhanced nutritional value and functionality:*** Twin-screw extrusion can improve the nutritional value and functionality of food products. By controlling the processing conditions, it is possible to enhance the digestibility of proteins, improve the bioavailability of nutrients, and modify the physical properties of the food matrix to incorporate functional ingredients or additives.

Twin-screw extrusion has proven to be a highly suitable technology for various commodity products, surpassing single-screw extruders in performance. Considering the numerous advantages, it is anticipated that this technology will increasingly replace single-screw extruders in the processing of full-fat soya beans. The ongoing trend highlights the industry's recognition of twin-screw extrusion as a superior choice for efficient food and feed production.

ExtruAfrica is a non-profit training initiative of CFAM to bring stakeholders together and inform them on topical issues related to extrusion and the industry. Visit *www.ExtruAfrica.org.za* for more information on these events.

Chemical composition, protein quality indicators and in vitro protein digestibility of commercial soya bean meals from different origins for use in poultry feeding

By L Aguirre, L Cámara, A Smith, JJ Arroyo, AF de Juan, G Fondevila and GG Mateos

Soya bean meal (SBM) is the main source of crude protein (CP) and amino acids (AA) in poultry diets worldwide, with Brazil (BRA), the United States (US) and Argentina (ARG) as the main suppliers. From 2016 to 2021, Europe imported 31 million metric tons (MMT) of soya beans, the equivalent of which 40, 22 and 18% correspond to BRA, ARG and US, respectively (European Commission, 2022).

South Africa (SA), the largest soya bean producer in Africa (Cornelius and Goldsmith, 2019; FAO, 2022), does not export SBM to Europe and a possible problem is that the information available on the chemical composition and nutritive value of the SBM produced in the country is very limited.

Numerous factors, such as agronomic practices, weather conditions, latitude (day length and light intensity) and seed quality, affect the chemical composition, protein quality and nutritional value of the soya beans and thus of the corresponding SBM (Westgate *et al.*, 2000; Karr-Lilienthal *et al.*, 2004; García-Rebollar *et al.*, 2016; Ibánez *et al.*, 2020).

Effects of heat

Trypsin inhibitors (TI), the main antinutritional factors present in raw beans, are inactivated by heat, a process that increases the nutritional value of the SBM and its use in poultry diets. However, an excess of heat increases the incidence of Maillard reactions, reducing the digestibility and quality of the protein and consequently, the energy content of the SBM (WPSA, 1989; Fontaine *et al.*, 2007; Thakur and Hurburgh, 2007; González-Vega *et al.*, 2011).

Because of cost and complexity, TI and Maillard's reactions are not usually analysed under commercial conditions and protein quality is estimated indirectly using laboratory procedures such as urease activity (UA), protein dispersibility index (PDI) and KOH solubility (KOH).

Urease, an enzyme present in raw beans, is inactivated by heat at a rate that resembles that of the TI (Balloun, 1980; Waldroup *et al.*, 1985). Consequently, high UA values are indicative of under-processing, with an excess of TI remaining in the meal. Protein dispersibility index and KOH evaluate the quality of the protein of the SBM by measuring, under controlled conditions, its solubility in water or potassium hydroxide, respectively.

High values indicate under-processing, with a high proportion of TI remaining in the meal whereas low values reflect over-cooking, with a high incidence of Maillard reactions and reduced digestibility of the AA (González-Vega *et al.*, 2011).

In vivo or in vitro digestibility

The AA digestibility of the SBM can be determined in vivo or in vitro. In vivo methods are expensive and time-consuming and require the use of live birds which limits their use in practice (Frikha *et al.*, 2012; Ravindran *et al.*, 2014; Mateos *et al.*, 2019). In vitro methods simulate the digestive processes that occur in the gastrointestinal tract of the birds and are simple, faster and more convenient in practice than in vivo methods (Boisen and Eggum, 1991; Bedford and Classen, 1993). However, the information available on the in vitro digestibility of the protein fraction of the SBM is scarce (De Coca-Sinova *et al.*, 2008; Frikha *et al.*, 2012).

The hypothesis tested in this study was that the chemical composition, protein quality and in vitro protein digestibility of commercial samples of SBM should vary among countries and that the nutritional value of the SBM for poultry could be estimated more accurately from the chemical composition and protein quality of the SBM than from table values. The objectives of this research were to compare the influence of the origin of the beans (ARG, BRA, US and SA) on the chemical composition, protein quality, in vitro protein digestibility and nutritional value of commercial samples of SBM.

Results: Chemical composition

The chemical composition of the SBM was affected by the country of origin of the beans (*Table 1*). On an 880g/kg dry matter (DM) basis, the SA meals had the lowest ash and the highest EEh content of all the

Table 1: Chemical composition (g/kg) of the soya bean meals (880g dry matter/kg).

	Average						Range				Coefficient of variation (%)			
Bean origin[a]	**ARG**	**BRA**	**US**	**SA**	**SEM[b]**	**P-value**	**ARG**	**BRA**	**US**	**SA**	**ARG**	**BRA**	**US**	**SA**
Dry matter	886^{y}	888^{y}	885^{y}	900^{z}	1,26	< 0,001	865–909	873–912	858–899	887–918	0,94	0,96	0,85	0,81
Ash	68,8^{z}	67,4^{z}	66,9^{z}	60,7^{y}	0,490	< 0,001	62,9–73,4	59,8–78,1	60,7–75,9	56,1–66,1	4,21	5,54	4,88	3,76
Crude protein	462^{y}	469^{z}	462^{y}	459^{y}	1,72	< 0,001	443–480	442–498	442–489	434–475	1,70	2,95	2,23	2,35
Ether extract[c]	18^{y}	19^{y}	19,4^{y}	26,8^{z}	0,841	< 0,001	8,92–28,7	10,2–27,8	10,9–30,2	15,7–38,7	30,4	27,4	26,5	20,3
Sucrose	68,6^{x}	58^{w}	73,3^{y}	87,6^{z}	1,25	< 0,001	51,7–82,3	41,8–72,8	47,3–90,3	67,6–97,7	10,3	14,1	12,4	8,19
Stachyose	46,7^{yx}	44,5^{x}	50,8^{z}	48,3^{zy}	0,822	< 0,001	34,2–58,4	33 –59,4	39,9–60	33,3–59,4	11,6	11,5	8,29	12,3
Raffinose	12,5^{z}	13,6^{z}	11,2^{y}	11,1^{y}	0,372	< 0,001	9,94–17,3	10 –21,9	8,32–18,7	7,71–16,2	14,3	18,9	20,4	23,4
Oligosaccharides[d]	59,2^{zy}	58,1^{y}	62^{z}	59,3^{zy}	0,881	0,017	44,3–71,6	44,3–71,6	53,3–72,7	41 –70,6	10,61	10,29	7,17	9,20
Starch	6,26	5,93	6,08	5,90	0,140	0,152	4 –7,20	4 –9	5 – 9	5 –7	10,8	19,3	15,1	12,6
Crude fibre	41,8^{y}	46,3^{z}	41,8^{y}	37,5^{x}	0,901	< 0,001	34,3–56,1	35,3–66,8	35,7–51,4	29,9–47,6	14	16,8	9,7	11,9
Neutral detergent fibre	87,9^{zy}	92,6^{z}	87,2^{zy}	82,3^{y}	2,02	< 0,001	68,9–123	70,3–142	69,3–107	63 –99,8	14,9	16,6	10,5	15,5
Σ of components[e]	890^{y}	891^{y}	896^{zy}	902^{z}	2,02	< 0,001	867–919	862–913	866–919	873–919	1,58	1,19	1,53	1,37

[z, y, x, w] Means within a row, without a common superscript, differ significantly (P < 0,05).
[a]ARG = Argentina, BRA = Brazil, US = United States and SA = South Africa. [b]Standard error of the mean (n = 40 per origin).
[c]After previous HCl hydrolysis. [d] Stachyose + raffinose. [e] Moisture, ash, crude protein, ether extract, starch, sucrose, stachyose, raffinose and neutral detergent fibre.

meals (P < 0,001). Sucrose (87,6 and 73,3 vs 68,6 and 58g/kg; P < 0,001) and stachyose (48,3 and 50,8 vs 46,7 and 44,5g/kg; P < 0,001) contents were higher and raffinose (11,1 and 11,2 vs 12,5 and 13,6g/kg; P < 0,001) was lower for the SA and US meals than for the ARG and BRA meals. Starch content was low (6 ± 0,9g/kg) and was not affected by the origin of the beans.

The CP and CF content (g/kg) was higher (P < 0,001) for the BRA meals (469 and 46,3) than for the SA (459 and 37,5), ARG (462 and 41,8) and US (462 and 41,8) meals. Also, NDF was higher for the BRA meals than for the SA meals, with the ARG and US meals being intermediate (92,6, 82,3, 87,9 and 87,2g/kg, respectively; P < 0,001).

Independent of the origin of the beans, the greatest coefficient of variation (CV) among the variables studied was observed for EEh, raffinose and sucrose values (CV = 30,5, 20,9 and 18,4%, respectively) and the lowest (CV = 2,50%) for CP. When the data were sorted by the country of origin of the beans, the highest variability for most components (CP, NDF, sucrose and raffinose) was observed for the BRA meals.

Amino acid content and profile

The contents of Lys and of the sum of five key AA (Σ Lys, Met, Thr, Trp and Cys) in poultry diets of the SBM were not affected by bean origin, despite the significant differences in CP content detected. The sum of the profile of the five key AA was better for the SA meals than for the BRA meals, with the US and ARG meals being intermediate (14,3, 14, 14,2 and 14,2g/100 g CP, respectively; P < 0,001). In fact, Lys profile (g/100g CP) was better for the SA and US meals than for the BRA and ARG meals (6,18, 6,13, 6,11 and 6,08g/100g, respectively; P < 0,001).

Macro-mineral and trace element contents

The macro-mineral content of the SBM varied with the country of origin of the beans, with the SA meals having less Ca (2,31, 3,45, 3,53 and 3,48g/kg; P < 0,001) and more P (6,86, 6,68, 6,72 and 6,36g/kg; P < 0,001) than the US, ARG and BRA meals, respectively. Potassium content was lower for the BRA and US meals than for the ARG and the SA meals (P < 0,001).

Independent of the origin of the beans, the highest variability was detected for Na (CV = 38,6%) and the lowest for K (CV = 5%) content. Trace element contents varied with the country of origin of the beans but except for Fe (143, 104, 104 and 101mg/kg for the BRA, ARG, US and SA meals, respectively; P < 0,001), the differences were of limited practical interest.

Protein quality indicators

The SAF SBM showed the highest values for all protein quality indicators, whereas the lowest values were for the ARG SBM (P < 0,001). However, all values were generally within acceptable values for protein quality. Irrespective of the origin of the bean, the variability was highest for UA (CV = 125%) and lowest for KOH (CV = 6,15%). When the data was sorted by the country of origin of the meals, the lowest variability for all protein quality indicators, except UA, was observed for the US meals.

In vitro CP digestibility

The IVDP at 1h (0,779, 0,773, 0,759 and 0,760; $P < 0{,}001$) and 3h (0,823, 0,825, 0,810 and 0,810; $P < 0{,}001$) post-incubation were greater for the US and the SA meals than for the ARG and the BRA meals. When the data was sorted by the country of origin of the beans, the highest variability was observed for the SA meals.

Correlations between chemical composition, protein quality and in vitro CP digestibility

The correlations among proximal analyses, protein quality indicators and IVDP values were numerous and therefore only the most relevant are presented. CP was negatively correlated with sucrose ($r = -0{,}397$; $P < 0{,}001$) and NDF ($r = -0{,}340$; $P < 0{,}001$) contents. Sucrose and oligosaccharides ($r = 0{,}324$; $P < 0{,}001$) and EEh ($r = 0{,}353$; $P < 0{,}001$) contents were also positively correlated. The most important correlations detected among protein quality indicators were between TIA and KOH ($r = 0{,}602$; $P < 0{,}001$) and between TIA and PDI ($r = 0{,}368$; $P < 0{,}001$).

UA showed a weak correlation with PDI ($r = 0{,}257$; $P < 0{,}01$) but not with KOH or TIA. As expected, the highest correlation among all variables presented was between IVDP at 1h and 3h post incubation ($r = 0{,}834$; $P < 0{,}001$). Furthermore, significant correlations were observed between IVDP at 1 and 3h post-incubation and TIA ($r = 0{,}364$ and $0{,}353$, respectively; $P < 0{,}001$) and KOH ($r = 0{,}227$ and $0{,}217$, respectively; $P < 0{,}05$) but not with PDI or UA.

Conclusion

The chemical composition, protein quality and nutritional value of soya bean meals varied according to the country of origin of the beans. The in vitro data on protein digestibility suggest that KOH solubility is a better indicator of the quality of the protein fraction of the soya bean meal than the protein dispersibility index or UA.

The correlations with greater practical interest among the variables studied were found between the in vitro protein digestibility and trypsin inhibitor activity and KOH. The high sucrose and low neutral detergent fibre content, together with the high in vitro digestibility coefficient of the protein fraction and better amino acid profile, favour the use of soya bean meals from SA and the US versus soya bean meals from Argentina and Brazil in poultry diets.

However, the lower crude protein content and the high variability in trypsin inhibitor activity and in vitro digestibility coefficient of the protein fraction values reduce in part the advantages of the South African meals over the other meals. To increase the accuracy of the determinations, the matrices on the nutritional value of soya bean meals used in the formulation of poultry diets should take into consideration the chemical composition and the country of origin of the beans, especially the sucrose content and the digestibility of the protein fraction of the meal.

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Canola crushing it

By Susan Reidy, World-Grain.com

Fuelled by blossoming demand for renewable diesel production, canola is seeing a surge in production and crush capacity across the world.

Global canola/rapeseed production for 2023/24 is projected at 87,4 million tons, a slight decrease from 2022/23, but only the second time that output has been over 80 million tons. Top canola/rapeseed producers include Canada, the European Union (EU), China, India and Australia.

The canola plant produces pods that contain small black seeds, made up of approximately 45% oil, roughly double the oil content of soya beans. The seeds are crushed to release the oil, which may be used for human consumption and as a feedstock for biofuels production. The solid parts of canola seed are processed into canola meal, which can be fed to livestock and potentially as plant-based protein for humans.

Crush figures on the rise

Global crush in 2023/24 is estimated at 81,1 million tons, up 300 000 tons from the revised 2022/23 crush forecast, according to the US Department of Agriculture's (USDA) *June Oil Crops Outlook*. Crush is expected to grow even more with multiple global agribusinesses announcing plans for new facilities.

Canada, the leading canola producer and top exporter, will see some of the most explosive growth, with an anticipated 50% increase in crush by 2024 or 2025. Demand for renewable diesel to meet government requirements is the key driver, said Chuck Penner, owner of LeftField Commodity Research based in Winnipeg, Manitoba, Canada.

"It's almost entirely driven by government policy, where the government decides fuel sources need to be more sustainable," he said. "What you see is along with the crush plant, there's also a refinery being built nearby to produce renewable diesel."

If realised, the new global crush capacity could mean a shift in trade flows as nations such as Canada, a leading canola exporter, instead start utilising a larger percentage of their crop domestically. Increased crush also means more canola meal co-products. Finding markets for more meal could be difficult, especially as soya bean meal production also increases.

"The huge challenge in all of this is going to be the meal, because if you crush another six million tons of canola within Canada, and you're also crushing a whole lot more soya beans in the US, North America is going to be flooded with meal," Penner said. "There's only so much you can do with that without going offshore."

Growing demand

Global canola/rapeseed production is forecast at 87,4 million tons, down slightly from an estimated 88,3 million tons in 2022/23 but up from 75,1 million tons in 2021/22, according to the USDA's *Oilseeds: World Markets and Trade* report released in July.

Agriculture Canada said in its June report that production for 2022/23 is estimated at 18,2 million tons with about half headed to export and half to domestic crush.

Acreage is expected to increase slightly in 2023/24, with production estimated at 18,4 million tons, assuming normal area abandonment and trend yields.

Canada trimmed yield estimates because of dry conditions, Penner said, with drought in some areas. Production took a huge hit in 2021 due to drought, with production only reaching 13,7 million tons. Totals bounced back in 2022 but yields were still below average, Penner said.

"We had some strong growth in acreage eight to ten years ago, but then more recently, those trends have turned decidedly sideways."

After three record crops in a row, production in Australia this year is expected to be smaller, but not as small as originally expected, Penner said. Production is estimated at 4,9 million tons, down 41% from record-setting totals in 2022/23 but still 15% above the ten-year average, according to ABARES. Acreage dropped 11% to 3,5 million ha but is the second largest area on record.

The EU's rapeseed production for 2023/24 is forecast at 20,2 million tons, with harvested area up 2% from last year.

"In Canada, production has levelled off, but in these other countries it's been trending higher," Penner said. "Those kinds of trends could continue, which then fills in the gap that's left by Canadian canola."

There is potential to grow capacity in Ukraine, Australia and even the US, he said. The US has seen significant growth recently, with canola production increasing 45% from 2021 to 2022 to a total of 1,79 million tons, according to the National Agricultural Statistics Service of the USDA. Planted acreage increased from 155 000 acres (62 726ha) in 1991 to an estimated 2,28 million acres (922 683ha) in 2023/24.

Effect of drought stresses

Kansas State University (KSU) researchers have compiled an analysis to better quantify the impact of different timings and durations of heat and drought stresses on seed and oil yields and quality. KSU held informational meetings this May in Kansas and Oklahoma about the crop for new and experienced growers, reaching more than 175 people. The meetings were the result of a partnership between KSU and Scoular, which announced plans in April to recommission a canola facility in Kansas.

Scoular's plans for the facility in Goodland, Kansas, US, which it purchased in 2021, include renovations to allow for the crush of canola and soya bean seeds, which will be used as feedstock for renewable fuels production. Scoular will intake and export product through its

already-established process for loading and unloading railcars and trucks.

Crush expansion

The Scoular facility is one of the latest in a flurry of canola crush expansion and new facility announcements that started in 2021. Canada has the greatest possibility for crush expansion with five major announcements since 2021 that will add 6,7 million tons of processing capacity by 2025, according to the Canola Council of Canada. That represents a 60% increase from the current capacity of 11,1 million tons.

In Regina, AGT Food and Ingredients Inc and Federated Co-operative Ltd (FCL) are partnering on an Integrated Agriculture Complex that will include a $360 million canola crush facility with a capacity of 1,1 million tons per year.

The complex also will include FCL's renewable diesel plant, which will use canola oil and other feedstocks such as animal tallows to produce 15 000 barrels per day of renewable diesel. The crush facility will provide approximately 50% of the renewable diesel plant's feedstock requirements with the rest coming from other canola crush facilities.

Cargill also has plans for a crush facility in Regina, breaking ground last summer on a facility that will have a capacity of one million tons per year. Operations are expected to start in 2024. Cargill also said it planned to update and modernise the canola facilities in Camrose and Clavet.

The company is upgrading oilseed facilities in Australia, including more canola capacity at its Footscray facility.

Projects in the pipeline

Other Canadian projects include Louis Dreyfus Co (LDC), which announced this spring plans to add a crushing line to its Yorkton, Saskatchewan, Canada, facility, doubling crush to more than two million tons; Richardson International is doubling canola capacity to 2,2 million tons at its Yorkton facility; and Viterra plans to construct a 2,5-million-ton-per-year facility in Regina, with operations starting in 2024.

Whether all the announced projects will materialise remains to be seen. At least one project already has been scrapped. Ceres Global Ag Corp last June suspended plans for a canola crush facility in Northgate, Saskatchewan, Canada, for various reasons, including higher costs than initially projected and shifting macro-economic conditions. The $350 million facility would have processed 1,1 million tons of canola and refined more than 500 000 tons of canola oil per year for food and fuel.

"Because they are generally partnerships between a multi-national grain company and a major petroleum producer, they've got pretty deep pockets," Penner said.

Keeping up with demand

With Canada's canola production still struggling with dry conditions and dropping yields, it might be difficult for

Woeker met die Wortelsone

Richard Bamberger
InteliGro Gewas Adviseur
www.inteligro.co.za

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intelligent crop solutions

'n Produsent se sukses word nie net deur die kwantiteit en kwaliteit van die oeste bepaal nie, maar ook in die volhoubaarheid van die produksiepraktyke.

Verskeie plant- en verbouingsfaktore dra by tot die realisering van so 'n suksesvolle oes. Aangesien die wortelstelsel nie sigbaar is nie, word daar dikwels van die kritiese rol wat hierdie organe in produksie speel vergeet.

Die wortelsisteem is 'n gesofistikeerde orgaan waarbinne verskeie biochemiese prosesse en interaksies met die risosfeer plaasvind. 'n Deeglike kennis van hierdie prosesse en interaksies word benodig om volhoubare opbrengste te laat realiseer.

Wat benodig 'n plant se wortels?

Wortels benodig struktuur om die plant te anker en te ondersteun. In die natuur dien grond as die ondersteuningstruktuur, maar wortels kan in verskeie mediums groei, of selfs waar geen medium teenwoordig is nie bv: aeroponiese sisteme.
Genoegsame water, die regte voedingstowwe en beskikbare suurstof is krities tot 'n gesonde wortelstelsel.

'n Optimale pH binne die groeimedium veroorsaak dat elemente opneembaar is wat element tekorte in die plant verhoed.
Die teenwoordigheid van voordelige mikrobe aktiwiteit in die risosfeer kan 'n beskermings- asook voedingsfunksie verrig.
Die stikstofbindende bakterieë rhizobium op sojabone is 'n goeie voorbeeld van so 'n bakterieë. (***Regs***)

'n Gesonde wortelstelsel se belangrike funksies

Die wortelstelsel het verskeie funkies waarvan die vernaamste insluit:

- dien as ankers;
- versterk natuurlike weerstand teen biotiese en abiotiese stres;
- dra by tot effektiewe fotosintese;
- vervoer water en voedingstowwe.

Dis egter belangrik om te onhou dat 'n optimaal funksionerende wortelstelsel lei tot 'n groter grond-wortel kontak area. Hierdie laat toe vir effektiewe opname van water en voedingselemente asook meer wortelafskeidings.

Soos die wortelstel vernuwe en versterk, dra so 'n stelsel direk by tot 'n verhoging van organiese materiaal in die grond.

Dit verhoog die grond se waterhou vermoë, verlaag verdamping en het tesame met die verhoogde wortel-afskeidings 'n voordelige effek op mikrobiese aktiwiteit.

Wat is uitdagings en bestuursmoontlikhede?

Wisselbou kan grondkompaksie verminder sowel as insek- en siektedruk verlaag. Dit is egter belangrik dat faktore soos nutriënt ontrekking, gewas sensitiwiteit en wortelgroeipatrone in ag geneem word met die beplanning van 'n wisselboustelsel. Meganiese bewerking kan meer as net grondkompaksie teenwerk. Die korrekte bewerking kan spore, eiers of insekte dieper in die grond of op die grondoppervlak plaas. Hier word die spore, eiers of insekte aan nuwe elemente soos direkte sonlig blootgestel en sterf.

Die nodige kennis van beide die bewerkingspraktyk en insek of swam is egter hier krities om sukses te behaal. Natuurlik het konvensionele plantbeskerming- en voedingsprodukte ook 'n rol te speel om bostaande uitdagings te verminder en verhoed.

Bekalking van grond en fulviensure kan kompaksie verminder en die korrekte posisionering van berokingsmiddels, insek- en aalwurmdoders hou siekte- en insekdruk laag om suksesvolle oeste te realiseer.

InteliGro se geïntegreerde gewasbenadering fokus op 'n kombinasie van konvensionele, biologiese en meganiese bestuurs- praktyke vir die mees effektiewe oplossing. Kontak jou naaste InteliGro Gewas Adviseur vir 'n nommerpas oplossing om te verseker dat jou wortels optimaal funksioneer.

Ons is daar waar dit saak maak, want ons weet... dit begin op die plaas!

the country to supply the oncoming crush demand with domestic production and still maintain exports, he said. It's not just the amount, but the speed at which the crush increases are happening, Penner said.

"Canada can't increase canola production quickly enough to keep up with the rise in demand. There's going to be some serious dips in Canadian exports until we can get production back up."

Canada is the leading canola exporter, with 8,4 million tons exported in 2022/23 and an estimated 8,8 million tons expected to be exported in this marketing year.

"It would certainly come out of exports," he said. "Then you start looking at where the Canadian export markets are. The dominant ones would be China, Japan and Mexico. That's going to trigger a whole bunch of changes. For the global market, it will need to come from other countries that don't grow canola as widely or as frequently."

Penner said the 2021 severe drought was quite instructive in how the Canadian canola industry handles lack of supply. Domestic crushers are the most inelastic demand, so that stayed strong throughout.

"Canola prices hit record levels, but it was mostly the export demand that got rationed," he said. "We lost a little bit of capacity, and we did import a small amount of canola. Domestic crushers were the most aggressive bidders for canola from our farmers."

The new capacity is going to put upward pressure on all vegetable oil production, said Tanner Ehmke, lead economist, grains and oilseeds, CoBank. The concern, he said, is oversupply.

"But given the announced expansions and greenfield projects that are online and expected to come online in the next couple of years, that would hint there's going to be more demand for veg oils going forward," he said. "There are other feedstocks competing with vegetable oil, like yellow grease and beef tallow, so the market is flexible."

Biofuels feedstock

Driving the demand for canola is the demand for renewable diesel, spurred by government policies requiring lower emissions and improved sustainability. Several feedstocks can be used for renewable diesel, including vegetable oils, used cooking oil and animal fats.

Unlike biodiesel, renewable diesel is a hydrocarbon that is chemically equivalent to petroleum diesel and can be used as a drop-in biofuel. It can be transported in petroleum pipelines and be sold with or without blending in petroleum diesel.

Canola is well suited for biofuels production because of its high oil content, providing more feedstock for fuel production and less byproduct, and low levels of saturated fat, which is linked to improved cold weather performance.

Global production of renewable diesel has steadily increased since 2011, when production was just 1,21 million litres per year, according to the International Energy Agency (IEA). Production reached 13,62 million litres in 2022 and is estimated to grow to 16,81 million litres this year, reaching 26,6 million litres by 2027.

In the US, renewable diesel production skyrocketed 225% in the last two years to 2,6 billion gallons (98,4 billion litres) in 2022. Production estimates call for 4,1 billion this year with totals reaching 6 billion gallons (22,6 billion litres) and above by 2025, according to farmdoc at the University of Illinois, Champaign-Urbana, Illinois, US.

The US had 16 renewable diesel plants operating as of December 2022 and another 16 are expected to be operational by the end of 2025. Plant expansions and conversions are pushing capacities to more than 500 million gallons (1 893 billion litres) per year, farmdoc said.

One recent policy incentive includes the US Environmental Protection Agency's (EPA) ruling at the end of 2022 that canola-derived renewable diesel qualifies as advanced biofuels under the Renewable Fuel Standard. Canola industry leaders said the ruling levelled the playing field for canola with other oilseeds and provided a pathway into the US market.

Canola use for biofuel production is estimated at 2,5 billion pounds (11,3 billion kg) for 2022/23 and 2,8 billion pounds (12,7 billion kg) in 2023/24, according to the USDA.

"Canola use for biofuels has more than tripled over the last year," Ehmke said. "The market is finding an opportunity with canola oil."

Coproduct challenge

A major challenge will be finding uses for the meal, Penner said. With increasing canola and soy crush, North America is going to be flooded with meal, and there's only so much that can be done with that, at least right now.

"Canola meal from existing crush is going to the US and China," Penner said. "But really it has to compete against soymeal. And we're going to have a lot more soymeal."

Drought in Argentina and a drop in soya bean meal production opened up some opportunities to move canola meal into the export market, Ehmke said. But when Argentina comes back online, there will be more competition.

"It's been an opportunity for the past year, to back fill a lot of that export demand that was abandoned by Argentina, but Argentina is going to come back," he said. "That's going to be adding increased pressure on North American exports for soya bean meal and canola meal. But that will be an opportunity for end users."

New markets will have to be found, Penner said, possibly in southeast Asia. "If someone can find new uses for protein meal, they'll be able to do quite well, because it will be the byproduct now in the North American oilseed market," he said.

Protein Industries Canada, a Canadian Global Innovation Cluster focused on plant protein and plant-based co-products, said canola protein represents a "significantly underdeveloped opportunity."

Canola meal use outside of ruminant feed is limited, it said, because of its fibre and antinutritional content. Rather than find new markets, Protein Industries Canada is encouraging creation of new products. Canola protein can be suitable for a range of applications, including meat and dairy alternatives, beverages, bars and baked and ready-to-mix products, according to the US Canola Association.

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Export markets and the soya bean industry

By André van der Vyver and Juan-Pierre Kotze, SACOTA

The soya bean industry in South Africa is growing and expectations are that a record-breaking crop will be achieved for the second consecutive year. The growth in the soya bean crop can be attributed to a substantial increase in soya bean plantings with an additional 223 000ha planted since the previous season.

This, in turn, can be attributed to the much higher profitability of soya beans per hectare (refer to *Oilseeds Focus*, September 2022). Based on the sixth Crop Estimates Committee's (CEC) figures, South Africa is projected to produce an estimated 2 755 300 tons this year, an increase of 525 000 tons or 23,6%, following last year's record-breaking crop of 2 230 000 tons.

The national average yield for soya beans is expected to remain constant at 2,4t/ha. However, according to the Agricultural Research Council's (ARC) soya bean cultivar recommendations report, some cultivars achieved yields exceeding 4t/ha in certain areas such as Delmas, Standerton and Potchefstroom.

Based on profitability and cultivars, there is room for further increases both in area and yield. It is anticipated that new technology will drive profitability and yield even higher. An example is the new Intacta trait (MON87701 and MON89788), developed by Bayer and approved for general release in South Africa in 2021.

During the past season, seed companies have started to multiply the seed of which some will be available for planting by commercial producers.

Soya bean production has been growing by an average of 18% year-on-year since 2016, while local consumption has grown by only 8%. Except for certain coastal areas such as around Cape Town, local soya bean cake has almost completely replaced imported cake. The latter will be difficult to replace with local products, given the high transport cost from the inland crushing plants to Cape Town and vicinity. Therefore, if production continues to grow as expected, South Africa will be increasingly dependent on finding profitable export markets.

Expanding export opportunities

The growth in the exportable surplus over the last three years has created export opportunities for those multinational traders that were looking for new business. Indications are that this was not merely a once-off opportunity, which made the effort, time and risk worthwhile. If quality and price could match the demand from international buyers, the opportunity will be ongoing and soya bean exports will continue to grow.

ETG took the lead in 2022/23 and opened four new markets in Southeast Asia, namely Bangladesh, Malaysia, Thailand and Vietnam. It was the sole exporter of all the soya bean vessels during last season, amounting to 280 790 tons or ten vessels in total.

With the available surplus (after carryover stocks) at the end of the 2023/24 season (28 February 2024) predicted to be 491 747 tons, early market expectations are for a robust export season, with the number of exports projected to reach record levels once again. Major soya bean export destinations will again include Malaysia and Vietnam.

However, logistical bottlenecks at Durban Harbour will be the main challenge. Early seasonal export slots

Figure 1: Deliveries versus local demand.

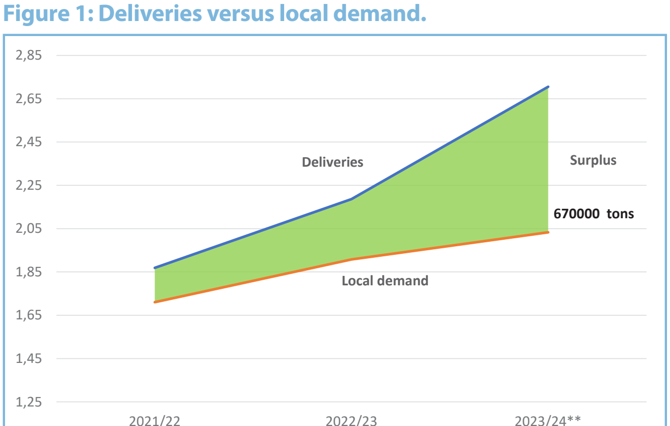
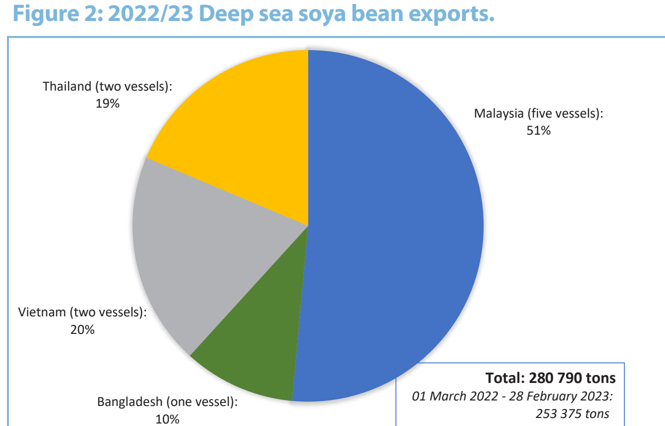


Figure 2: 2022/23 Deep sea soya bean exports.



in May 2023 were utilised by soya bean exporters, but thereafter the yellow maize export programme kicked in. All export slots until mid-October are booked for yellow maize exports. Traditionally yellow maize is exported during this period, more so as the yellow maize industry will have another surplus crop this year.

Limited facilities

Given the limited logistical and storage facilities in the harbour, it is very difficult to handle two different crops simultaneously. Therefore, soya bean exports have come to a standstill until approximately the fourth quarter when open slots are available. Four vessels were loaded out of Durban in May/June 2023. Maputo attracted South African soya bean exports again and one vessel was loaded and a second scheduled to complete in July 2023.

It is difficult to predict demand going forward, mainly for two reasons. Firstly, South African soya beans were priced very aggressively during May and June, but at the time of writing this article, we were more in line with other global exporters. Secondly, importers normally only buy two to three months in advance. Since we do not have slots available at present, it is difficult to forecast price competitiveness towards the end of the year.

East London offers another opportunity, but until July it was loading yellow maize. However, white maize and soya beans (since their expansion to the western production areas) are the logical choice for exports through East London. At the time the yellow maize export transactions were secured, it probably was the most profitable proposition. Since then, however, soya beans (or white maize) may have become a more profitable option and there is a high probability that we may see some soya beans exports through East London this year.

International markets

South African exporters are also looking at opening other soya bean markets, such as the vast Chinese market which offers immense potential for attracting business. China anticipates importing 97 million tons of soya beans in 2023/24. South Africa signed the required soya bean export protocol with China last year, hence this market is now open to be exploited. Other possible countries where negotiations have commenced include Egypt and Indonesia.

At a free on board (FOB) price of US$588 per ton and an exchange rate of R17,70 to US$1, one soya bean vessel of 30 000 tons creates US$17,64 million (or R312 million) in forex exchange for South Africa. Given the higher profitability of soya beans versus maize to producers, and therefore the additional income flowing back to rural areas, it makes economic sense to continue growing the soya bean industry. This is despite challenges to align pricing opportunities with available transport (road and rail) and export slots in the harbours.

For more information, visit *www.sacota.co.za* or send an email to info@sacota.co.za.

Supply drives soya bean markets

By Christiaan Vercueil, agricultural economist, Grain SA

It is important to understand that the international market is currently referred to as a 'weather market'. What this means is that the weather, especially in the United States (US), has a major effect on what happens to price trends in international grain markets.

There are two types of price movements, namely supply-driven and demand-driven price movements.

Supply-driven price movements

These are movements in prices due to the production and availability of grain stocks. These price movements tend to be very volatile but are often short lived. Examples of supply-driven price movements are when prices react to dry or wet weather in certain production areas and to news regarding the availability of grain, such as the news that Russia did not extend the Black Sea shipping agreement.

Demand-driven price movements

These price movements are caused by the actual use or need of grain and oilseeds. These movements are usually of a stable and long-term nature.

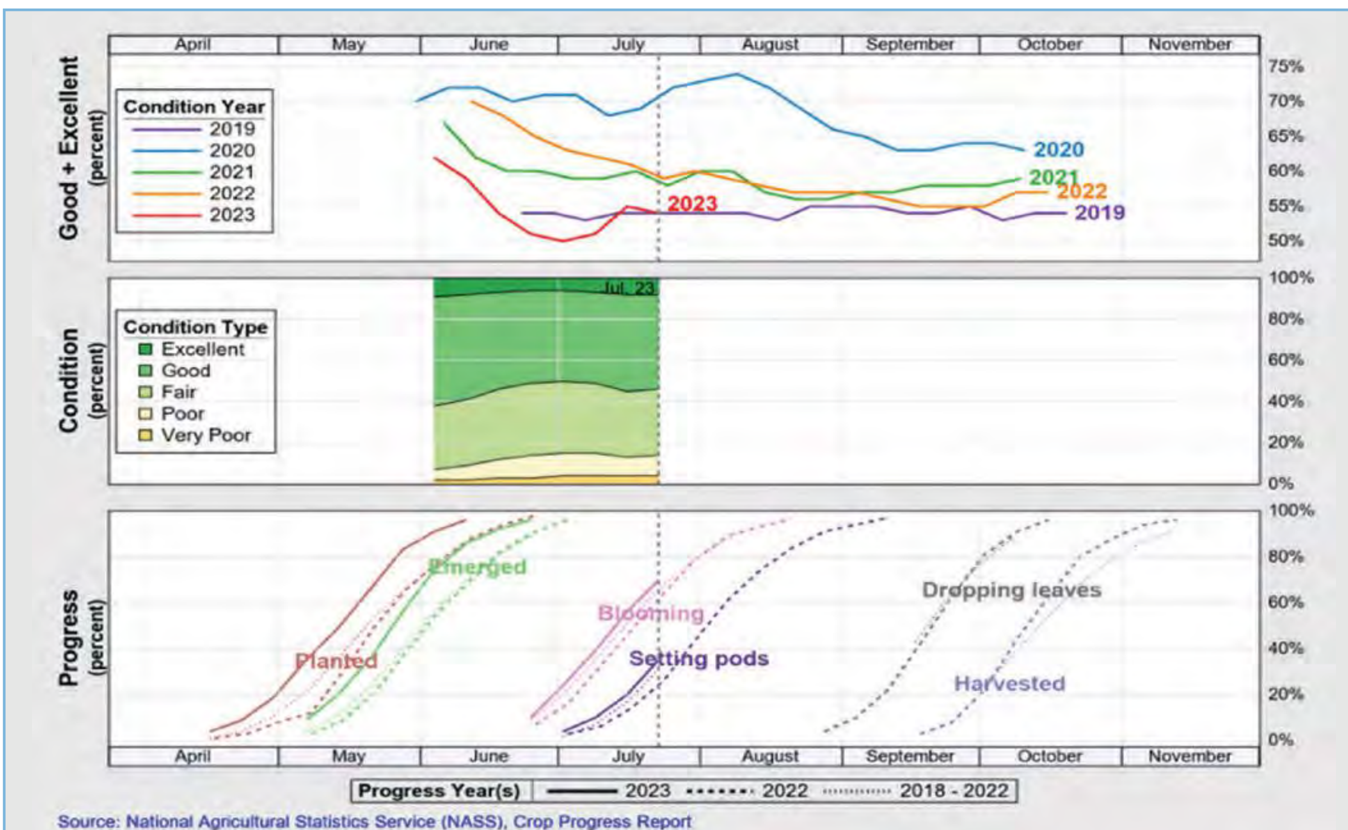
Dry weather has been a threat to the soya bean crop in the US since the beginning of the 2023 planting season (*Figure 1*). Crop conditions dropped to a 50% good-to-excellent condition between June and July, but managed to recover to 54% in the 24 July report.

During the previous season, US soya bean crop conditions were at 59% good-to-excellent condition. This created a crop scare price rally which supported prices for a brief period. On 30 June, the United States Department of Agriculture (USDA) released an acreage report indicating that soya bean acreage declined by 5% from the previous season. Both these factors supported US soya bean prices.

In the local market

Since the 2020/21 production season, soya bean production increased in such a manner that prices moved from import to export parity. Since then, South Africa has been competing mainly with Brazil, Argentina and the US in the international export markets. *Figure 2* shows the relationship between the

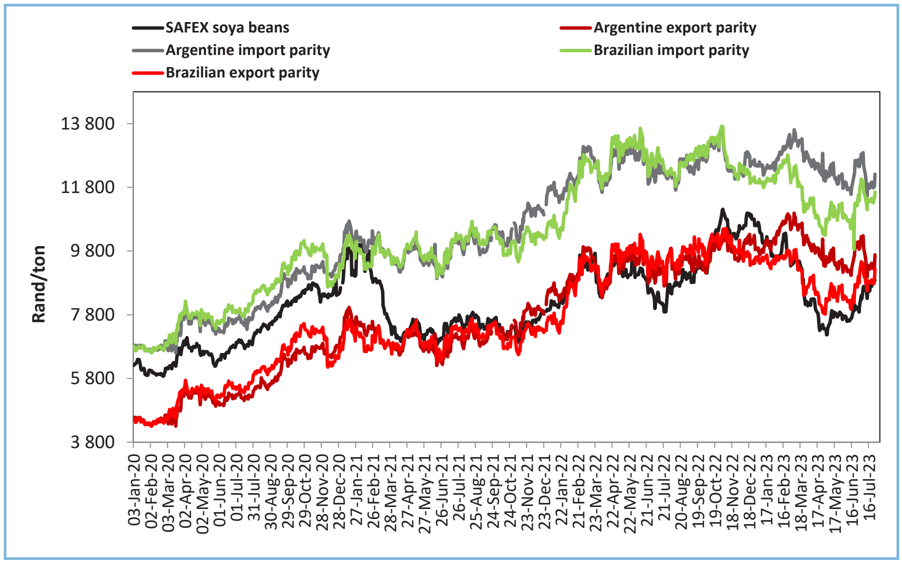
Figure 1: Crop progress and condition of soya beans in the United States, 2023.



Source: National Agricultural Statistics Service (NASS), Crop Progress Report movement of Argentine, Brazilian and local soya bean prices.

The crop scare price-rally previously mentioned can be seen in the Argentine export parity prices and the Brazilian and local prices followed this trend. Prices again came under pressure due to improved weather conditions. On 17 July, Russia declined the opportunity to extend the Black Sea shipping deal which entailed that cargo ships may sail in the Black Sea region without the threat of military action. This supported grain and oilseed prices.

Figure 2: Parity prices of soya beans delivered in Randfontein. (Source: Grain SA)



Conclusion

All the factors mentioned can be described as supply-driven price movements. The volatility of these price movements is clearly visible, as prices have changed significantly over very short periods.

Taking a step back and looking at the fundamentals of the grain and oilseeds industry, it is clear that production and closing stocks are estimated to be higher than in the previous season and therefore the expectation is that prices will rather see downward pressure in the long run.

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Update: Effect of fertiliser prices on the grain industry

By Christiaan Vercueil, agricultural economist, Grain SA

Traditionally, between 30 and 50% of a grain and oilseed producer's existing input costs are spent on fertiliser. Fertiliser makes up such a large portion of input costs that any change, especially a price increase, can affect profitability drastically.

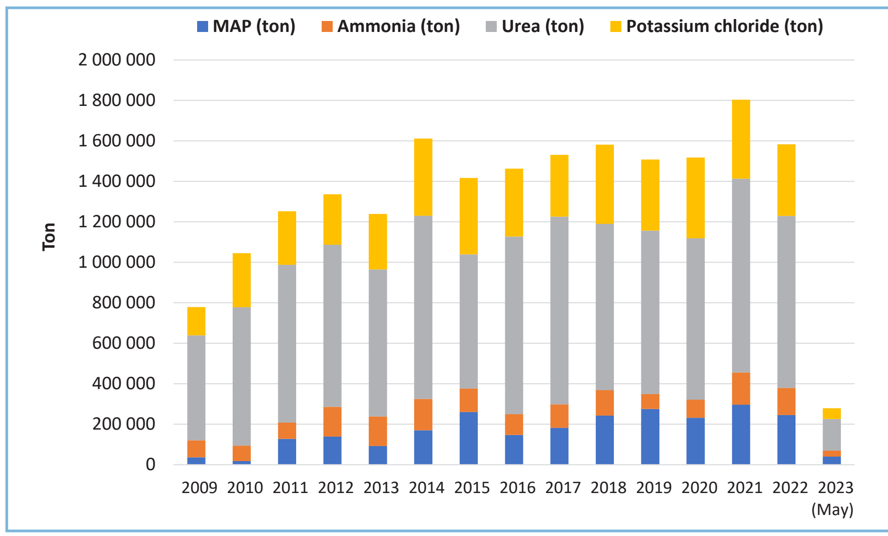
Because South Africa is a net importer of fertiliser, it tends to further aggravate the situation since all imported fertilisers are not only affected by their actual price, but by a whole range of factors such as the exchange rate and transport costs.

Import volume and price changes

Figure 1 illustrates South Africa's fertiliser imports of monoammonium phosphate (MAP), ammonia, urea and potassium chloride from various countries since 2009. Although not the only fertilisers imported, these are four of the five most important products imported.

As of 2009, fertiliser imports for these four products increased by 103% in total. During 2021, South Africa imported a total of 1 803 348 tons of just these four fertiliser products from various countries. Besides the increase in import volume, the exchange rate of the rand to other major currencies also weakened sharply from 2009 onwards, which further intensified the effect of price increases.

Figure 1: Four of the five most important fertilisers imported into South Africa.



In 2022, almost 1,6 million tons of these four products had been imported, showing a 12% decrease from 2021. From January to May only 18% of the previous season's total imports had been imported into South Africa.

Table 1 contains the average price changes for nitrogen (N), phosphate (P) and potassium (K) during July last year, compared to July 2023. It is a welcome relief to see a slight decline in prices compared to the previous year.

Looking at the fertiliser requirements of different parts of the country, one notices that on average, the Western Free State uses 72 units of N, 16 units of P and 14 units of K per hectare. The Eastern Free State uses 100 units of N, 19 units of P and 27 units of K per hectare. Irrigated areas use 286 units of N, 52 units of P and 80 units of K per hectare.

Table 2 provides a comparison of the average fertilisation requirements for these three regions in July 2022 and July 2023. On average, the cost of fertiliser declined by 41%.

Table 1: Price comparison of nitrogen, phosphate and potassium for July 2022 and July 2023.

	Nitrogen	Phosphate	Potassium
Average price: July 2022 (R/kg)	R39,9	R95,3	R47,3
Average price: July 2023 (R/kg)	R26	R51,9	R22,7
Change (year-on-year)	-35%	-46%	-52%

Table 2: Change in fertiliser cost per hectare for July 2022 compared to July 2023.

	Nitrogen	Phosphate	Potassium	Price: July 2022	Price: July 2023	Change
Eastern Free State: Average units (kg/ha)	100	19	27	R7 078	R4 199	-41%
Western Free State: Average units (kg/ha)	72	16	14	R5 060	R3 020	-40%
Irrigation: Average units (kg/ha)	286	52	80	R20 151	R11 951	-41%

Fertiliser affordability

Figure 2 indicates the affordability of fertilisers compared to the Safex price of maize. Fertilisers, which account for between 30 and 50% of input costs, have become less and less affordable, which means the producer's margin for trade has weakened excessively.

This puts pressure on producers' profitability and can result in fewer hectares being planted, especially maize. Recently, fertiliser prices declined due to the market becoming more accustomed to the Russian-Ukraine war, and declining energy prices and lower transportation costs.

This information paints a clear picture of the extreme daily challenges that producers face while trying to stay afloat. Fertiliser is not the only input that has seen sharp price hikes; the cost of energy sources such as fuel and electricity have also risen sharply, as has the price of seed and chemicals. It is becoming progressively more difficult for farming operations to remain profitable and sustainable.

Although fertiliser prices are following a downward trend and, according to the affordability index, are becoming more affordable, inputs for the current season were purchased when prices were higher. Grain prices have also been on a negative curve since the beginning of 2023, making profitability very difficult in a season where inputs were purchased at high prices. In the long term, this trend is expected to continue with international production at higher levels.

Since there is little room for mistakes, producers must ensure they are not being taken for a ride by fertiliser suppliers. Do the homework, make sure the representative's prices are market related, compare offers to find the best price, and select the most suitable offer for your purposes.

Figure 2: The affordability of fertilisers.

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Lagging regulations dampen NBT advances

By Susan Marais, Plaas Media

While the South African Cultivar and Technology Agency (Sacta) has been able to increase its levy collection from R37 million in 2016/17 to almost R143,36 million in 2022/23, holes in regulatory processes are hampering the development of new breeding techniques (NBTs).

This came to light during Sacta's recent annual general meeting. Sacta administers the breeding levies of certain self-pollinated grain and oilseed crops, specifically wheat, barley, oats, soya beans and lupins. "For a few decades we did not see any significant investment in self-pollinating seeds, but levies have changed the ball game," Andrew Bennett, CEO of Sacta, said. "Better genetics have become available; producers are able to increase their yields and more seed companies have shown an interest in investing in South Africa."

Concerns over new regulations

While levies have led to numerous multinational seed companies investing in self-pollinating seed in South Africa, the country's regulatory authorities' adoption of newer technology leaves a lot to be desired, said Annelize Crosby, head of Agbiz's legal intelligence.

In 2021 the Department of Agriculture, Land Reform and Rural Development (DALRRD) classified NBTs, including genome edited plants, as genetically modified organisms, which meant that it would be regulated under the *Genetically Modified Organisms Amendment Act, 2006 (Act 23 of 2006)*.

"It is problematic for the local industry that more and more new plant varieties, which are the result of selected gene editing technologies leading to new plant breeding innovations (PBIs), are being internationally recognised as non-GMOs, yet are subjected to costly risk assessments

Andrew Bennett, CEO of Sacta.

Sandile Mahlangu, Sacta's transformation manager.

and potential discrimination against GMO-products in South Africa," Crosby said.

The DALRRD's decision in this regard is seemingly a process-based interpretation, because such a conclusion would be nonsensical from a product perspective. "In many instances, it would be impossible to distinguish some NBT derived organisms from ones that may have evolved naturally."

To try and get the minister of DALRRD to overturn the executive council's decision, Agbiz has lodged an internal appeal, provided for in the *GMO Act*.

"We want South Africa to adopt a science-based products basis for GMO regulation," Crosby said. "To achieve this, the *GMO Act* should be amended to ensure that the definition of GMO is explicitly product based. The authorities must also introduce an induced genetic variation oversight mandate, which should include a confirmation of regulatory classification or pre-evaluation function."

Higher levy collections

Bennett indicated that while these regulatory processes were concerning, Sacta was not mandated to investigate this matter. "Sacta falls under the stewardship of the National Agricultural Marketing Council (NAMC) and our work is to efficiently collect and distribute a levy on certain self-pollinating grain and oilseeds. This must be done at as little cost as possible.

"The fact that Sacta was able to collect a levy on between 81 and 94% of all wheat, barley, oats and soya beans produced in South Africa over the past financial year, with an overhead cost of R8 million, attests to the agency's effectiveness," Bennett said. "For every R100 that Sacta collects, approximately R74,50 is distributed back to seed companies to fund their research on self-pollinated crops. A further R20 is spent on transformation, and administrative costs make up roughly R5,50 of the levy."

Transformation remains key

In accordance with NAMC guidelines, 20% of any statutory levy must be spent on transformation. Sandile Mahlangu, Sacta's transformation manager, said over the past year the agency helped 134 black producers develop their farming skills. These producers planted crops on between 10ha (irrigated land) and 200ha (dryland). "We would have liked to help more, but it is important to rather help fewer producers, but support them fully."

Apart from skills transfer through contractors, Sacta supports them financially by awarding three-year interest-free loans. The agency also financially supported 11 PhD students, 14 master's level students and three internships.

For more information visit *www.sactalevy.co.za.*

Sunflower cake with or without enzymatic complex for broiler chicken feeding

By Eveline Berwanger, Ricardo Vianna Nunes, Tiago Junior Pasquetti, Alice Eiko Murakami, Taciana Maria Moraes de Oliveira, Douglas Fernando Bayerle and Rafael Frank

Sunflower cake (SC) can be a good source of energy for broiler chickens and its use in feed formulation for animals can reduce production costs and contribute to sustainable animal production by reducing environmental contamination and improving the conservation of natural resources.

In a completely randomised design, a total of 850 birds were allotted in a 2×5 factorial scheme (with and without enzymatic complex) and five inclusion levels (0, 5, 10, 15 and 20%) of SC. There were five replications and 17 birds in each experimental unit. Data from performance, carcass yield and intestinal morphology was evaluated.

However, the chemical composition of SC can show variation due to the genetics of the cultivar and due to the processing of the seeds, which makes it essential to determine the nutritional values of SC before proceeding to include it in feed formulations.

Additionally, some factors can limit the feeding of SC to non-ruminants, such as its high concentration of non-starch polysaccharides, especially cellulose and lignin, which cannot be degraded by endogenous enzymes. The cellulolytic complex of the sunflower plant therefore acts as a barrier to birds' digestive systems, impairing enzyme action and increasing endogenous nutrient loss, thus reducing the availability of energy from birds' diets.

To increase the efficiency of nutrient utilisation from alternative foods, the addition of exogenous enzymes is commonly proposed. This study evaluates the performance traits, carcass yield and prime cuts, and the intestinal morphology of broiler chickens, from 22 to 42 days of age feeding diets with increasing levels of SC, with or without enzymatic complex supplementation.

Observations and conclusions

No interaction was observed between enzyme complex and inclusion levels of SC in relation to performance traits, prime cuts, organ yields and intestinal morphology. Non-ruminant animals are not able to digest non-starch polysaccharides and therefore the use of endogenous enzymes can be an alternative to improve nutrient utilisation and increase energy available to such animals.

However, in our study, no differences were observed between treatments with or without enzyme complex supplementation for performance traits (*Table 1*).

It is important to consider that enzyme supplementation occurred after 21 days of age, the stage in which birds already have a well-developed digestive tract with higher digestion capacity and absorption of nutrients. Tavernari *et al.* observed higher weight gain for broiler chickens aged one to 21 days that did not receive an enzymatic complex in the diet, although they did not consider energy recovery of enzymes in the diet formulations.

Feed intake, weight gain, final weight and feed to gain ratio linearly worsened as SC increased. Weight gain, final weight and feed involving the birds whose diets contained levels of 15 and 20% of SC showed worse values ($p < 0,05$) than the birds fed the control diet. When fed the enzymatic complex, birds improved ($p < 0,05$). As inclusion levels of SC increased, villus depth and villus crypt ratio in the duodenum, jejunum and ileum linearly reduced and the crypt depth linearly increased. Carcass yield linearly reduced as SC increased.

Based on performance, SC can be used up to 10% in broiler feeding from 21 to 42 days of age.

Table 1: Growth performance of broilers fed sunflower cake and enzymatic complex from 21 to 42 days of age.

Items	Feed intake (g)	Weight gain (g)	Final weight (g)	Feed: gain ratio (g/g)
Inclusion levels of SC (%)				
0	2,934.50 ± 16,86	1,682.37 ± 19,14	2,421.49 ± 19,35	1,746 ± 0,021
5	2,926.60 ± 11,92	1,633.92 ± 30,79	2,370.33 ± 33,03	1,796 ± 0,031
10	2,921.28 ±2 4,53	1,616.61 ± 18,13	2,356.08 ± 18,52	1,803 ± 0,020
15	2,912.46 ± 13,92	1,589.51 ± 20,51*	2,330.39 ± 21,09*	1,822 ± 0,017*
20	2,873.53 ± 17,38	1,542.72 ± 19,58*	2,284.42 ± 18,99*	1,864 ± 0,020*
With EC	2,911.85 ± 12	1,619.12 ± 15,85	2,357.99 ± 16,58	1,795 ± 0,015
Without EC	2,915.50 ± 11,65	1,606.93 ± 17,59	2,347.09 ± 17,45	1,819 ± 0,017
SEM	8,23	10,42	10,78	0,010
Levels×EC	0,93	0,97	0,97	0,96
EC	0,82	0,60	0,66	0,29
Levels	0,23	0,2	0,12	0,05
Linear	0,05	<0,01	0,04	0,01
Quadratic	0,37	0,54	0,53	0,45

SC: sunflower cake, EC: enzymatic complex, SEM: standard error of the mean.
**Dunnett's test, considered significant when p < 0,05.*

This article was condensed for publication in *Oilseeds Focus*. For enquires, email Taciana Maria Moraes de Oliveira at tacideoliveira@hotmail.com or visit *www.animbiosci.org/journal/view.php?doi=10.5713/ajas.15.0644.*

Review of soya bean carbohydrates

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Soya beans are the most widely used vegetable protein source for monogastric animals and are the most prevalent legume/oil seed crop in the world (FAO, 2008). Soya beans contain nearly as many carbohydrates as protein, yet the nutritional and/or anti-nutritional activities of these carbohydrates in animal feed are quite often ignored.

Poor growth performance has been observed when broilers were fed diets containing soya bean meal (SBM) as the sole dietary protein source (Irish and Balnave, 1993). It was observed that the poor growth of broilers fed SBM as the sole protein source was more pronounced with meals processed in Australia compared with the meals processed in the US. This response was assumed to be related to the higher fibre content of Australian processed meals (Irish and Balnave, 1993).

Factors of growth performance

The poor growth performance could not be explained by the digestibility, the amount of essential amino acids, or the process of heat treatment of the SBM tested. A significant relationship was observed between the water-soluble xylose content of the SBM and the improvement in weight gain obtained when sunflower meal replaced some of the SBM.

Growing pigs can utilise SBM efficiently, but weaning piglets respond to dietary SBM with reduced growth performance (Li *et al.*, 1991; Friesen *et al.*, 1993; Rooke *et al.*, 1998). The anti-nutritive effects of soya oligosaccharides and soluble non-starch polysaccharides (NSP) have been observed in weaning piglets (Veldman, 1993; Pluske *et al.*, 1998). It was reported that the removal of soluble NSP and oligosaccharide by ethanol/water extraction improved intestinal health and growth performance in weaning piglets (Hancock *et al.*, 1990).

The objectives of this paper are to review digestibility, nutritional values and anti-nutritional effects of soya bean carbohydrates, with a focus on the soluble non-starch polysaccharides and oligosaccharides; and to evaluate the impact of ethanol/water extraction on soya carbohydrates composition.

Carbohydrates in soya beans

Soya beans have approximately 8% seed coat or hull, 90% cotyledons and 2% germ (USDA, 2009). Soya beans are not only a great source of high-quality oil but are rich in protein and carbohydrates. Thus, dehulled soya beans contain 20% oil, 40% protein, 35% carbohydrates and 5% minerals on a dry matter (DM) basis (USDA, 2009). When the oil is extracted, the remainder, usually called the meal, has around 48% protein, 35-40% carbohydrates, 7-10% water, 5-6% minerals and less than 1% fat (3-4% of acid hydrolysed fat) (USDA, 2009). Carbohydrates are the least understood constituent in soya beans.

The carbohydrates in SBM consist predominantly of NSP and free sugars, such as mono-, di- and oligosaccharides (Choct, 1997). Starch is present at less than 1% (Choct, 1997). NSPs are classified into three main groups, namely cellulose, non-cellulosic polymers and pectic polysaccharides.

Different ingredients contain not only different amounts of soluble and insoluble NSP and oligosaccharides but also the structure and physiochemical characteristics of the NSP differ widely. Soya bean NSP is composed mainly of a mixture of pectic polysaccharides such as rhamnogalacturonans (types I and II), arabinogalactan I and xylogalacturonan (Fransen, 1999).

The carbohydrates in soya beans consist of approximately 10% free sugars (5% sucrose, 4% stachyose and 1% raffinose) (Macrae *et al.*, 1993) and between 20 to 30% NSP, in which approximately 8% are cellulose and the remaining are pectic polysaccharides (Choct, 1997).

It is also worth mentioning that the carbohydrate composition of soya beans varies according to the geographical locations where the soya bean was grown, harvest conditions and post-harvest processing (Karr-Lilienthal *et al.*, 2005). Thus, it is not surprising to find that the level of sucrose ranges between 3 to 8%, raffinose between 0,1 to 1,5% and stachyose between 1 to 6%.

Digestibility and nutritive value

Digestion refers to the disappearance of nutrients from the entire gastrointestinal tract as well as from specific parts of the tract, e.g., ileal digestibility. Since pigs and poultry do not have endogenous enzymes capable of digesting NSP and some oligosaccharides, the digestibility of these carbohydrates is achieved by chemical (acid in the stomach in pigs and crop in chickens) and microbial degradation.

A large portion of NSP is digested by the large intestinal microflora in pigs. The digestibility of NSP is affected by a multitude of factors which include animal species, age of animals, solubility, chemical structure and their quantity in the diet.

The solubility of NSP affects their digestibility in both pigs and poultry. In general, the soluble NSP are more digestible than the insoluble fraction. In pigs, the digestibility of soluble NSP is near complete, but that of insoluble NSP, such as cellulose, ranges from 34-60% (Bach Knudsen and Hansen, 1991). NSP digestibility in poultry is lower. Carre *et al.* (1990) observed an NSP digestibility value of 13% in cockerels fed a diet containing 6,9% NSP, where the only source of NSP was from defatted, de-hulled SBM.

In adult birds, Carre *et al.* (1995) suggested that the degradation of soluble NSP can be as high as 80-90%, whereas the insoluble polysaccharides remain un-degraded. Using an *in vitro* enzymatic digestion procedure, Honig and Rackies (1979) observed that the *in vitro* digestibility of total carbohydrates in whole soya beans,

Pigs can digest NSP better than chickens due to a better fermentative capacity in the large intestine and a longer digesta transit time.

dehulled, defatted soya flour and soya hulls were 40,7 and 58,4 and 2%, respectively.

Digestibility differs between livestock

There is a large difference in NSP digestibility between pigs and poultry (Choct and Cadogan, 2001). Pigs can digest NSP better than chickens due to a better fermentative capacity in the large intestine and a longer digesta transit time (Choct and Cadogan, 2001). However, a difference in NSP digestibility also occurs within the same species.

In pigs, the digestibility of NSP increases with the age of animals, since grower and finisher pigs can utilise dietary fibre better than young piglets. The amount of NSP in the diet influences their digestibility (Choct and Annison, 1990). The effect of inclusion levels of NSP on their digestibility is multifaceted.

The process of NSP digestion in pigs and poultry has the commonality of acid digestion in the upper part of the gut (stomach in pigs and crop in chickens) and microbial fermentation in the lower part of the small intestine and of the entire large intestine. In poultry, a small amount of physical digestion may occur as fibrous materials go through the gizzard where they are ground to fine particles. This section will attempt to cover the effect of NSP on nutrient digestion and absorption, on the gut microflora; the digestion of oligosaccharides and its fermentation products; the effect of the short-chain fatty acids (SCFA) on the gut; and the contribution of SCFA to dietary energy.

However, Jergensen *et al.* (1996) reported that the total contribution of SCFA to the metabolisable energy available to the bird is approximately 42kJ per day independent of the NSP source, which accounts for only 2 to 3% of the dietary ME.

In pigs, the fermentative breakdown of NSP in the large intestine can provide between 10 to 24% of the dietary energy for maintenance with an additional 1 to 4% of energy coming from the flow of organic acids produced in the ileum, depending on the type and amount carbohydrates in the diet (Bach Knudsen and Hansen, 1991). This highlights the capacity of the pig to use a large amount of carbohydrates by hindgut fermentation.

Elevated levels of NSP, the soluble fraction, lead to decreased nutrient digestion and absorption in poultry (Antoniou *et al.*, 1981; Choct and Annison, 1990) and, to a lesser extent, in pigs (Van Barneveld and Hughes, 1994).

Gut ecosystems

A slow-moving digesta with low oxygen tension in the small intestine could provide a relatively stable environment where fermentative microflora can establish (Wagner and Thomas, 1978). Choct *et al.* (1996) demonstrated a large increase in fermentation in the small intestine of broilers by adding soluble NSP to the diet.

At first, it could be thought that increased production of volatile fatty acids (VFA) would increase the energy content of the feed, but due to the drastic change in the gut ecosystem, the net effect was decreased nutrient digestion accompanied by poor bird performance.

The implication of increased dietary soluble NSP in the onset of other diseases, such as necrotic enteritis in poultry, has also been documented (Kaldhusdal and Hofshagen, 1992). It appears that if the NSPs are completely hydrolysed, the anti-nutritive effect on nutrient digestion and absorption and its association with the pathogenesis of certain diseases could be eliminated.

Murray *et al.* (1977) observed that the addition of gel-forming (soluble) polysaccharides (methyl cellulose and pectin) to a diet (6% as replacement of starch) caused a decrease in the apparent digestibility of nitrogen at the terminal ileum. The inclusion of an insoluble polysaccharide (10% of cellulose) as a replacement for starch had little effect on nitrogen digestibility.

NSP can also bind nutrients and form complexes with digestive enzymes and some regulatory proteins in the gut. Angkanaporn *et al.* (1994) showed that soluble NSP markedly increased endogenous losses of amino acids in chickens. The gut secretes some 20 hormones or regulatory peptides (Unvas-Moberg, 1992), some enhance nutrient absorption, and others depress it. Feed components that have effects on endogenous protein secretion ought to affect hormonal secretions.

Furthermore, viscous NSP can enhance bile acid secretion and subsequently result in a significant loss of these acids in the faeces of rats (Ide *et al.*, 1989). In addition, certain NSP can bind bile salts, lipids and cholesterol (Vahouny *et al.*, 1981) which could result in increased hepatic synthesis of bile acids from cholesterol to re-establish the composite pool of these metabolites in the enterohepatic circulation.

The continued 'drain' of bile acids and lipids by sequestration, and increased elimination as faecal acidic and neutral sterols, may ultimately influence the absorption of lipids and cholesterol in the intestine. These effects could lead to major changes in the digestive and absorptive dynamics of the gut, with consequent poor overall efficiency in nutrient assimilation by the animal.

SBM contains approximately 30% of NSP, including 14 and 16% of soluble and insoluble NSP, respectively, on a dry matter basis (Smits and Annison, 1996). Thus, the inclusion of high levels of SBM will add a high amount of soluble NSP in the diet and this will lead to an increased risk of intestinal disorder in weaning piglets.

Soya oligosaccharides

Lower molecular weight carbohydrates, such as oligosaccharides and fructans, are digested between 40-50% in the small intestine (De Schrijver, 2001) and are completely digested in the large intestine of the pig (Carre *et al.*, 1990). Generally, the consequence of oligosaccharide digestion is an increase in the number of *Lactobacilli* and *Bifidobacterium*, and a decrease in *Clostridia* and *Enterobacteria* (Nemcova *et al.*, 1999).

Other oligomers, such as mannan-oligosaccharides, are believed to physically bind to pathogens as well as stimulate the immune system (Spring *et al.*, 2000). Coon *et al.* (1990) reported that the ileal digestibility of raffinose and stachyose was very low in roosters (less than 1%), but the digestibility based on excreta collection was high (84 to 90%). Carre *et al.* (1990) estimated the apparent digestibility value for oligosaccharides to be 82% in cockerels fed a diet based on SBM and corn starch.

In pigs, the apparent ileal digestibility of galactooligosaccharides was 77% in a diet containing soya solubles, while the apparent total tract digestibility for the same diet was 100% (Smiricky-Tjardes *et al.*, 2003b).

Veldman *et al.* (1993) observed that the ileal digestibility coefficients of [alpha]-galactosides were 0,73 and 0,57, respectively, for a control diet containing corn starch and a test diet supplemented with soya velasses.

The addition of soya velasses (ethanol/water extract from soya flakes, containing 15,2% stachyose and 2,8% raffinose) resulted in a 25% reduction in organic matter and crude protein digestibility in piglets. The authors suggested that the decrease in indigestibility was the result of an increase in gut osmolarity and dilution of digestive enzyme activities and substrate concentrations.

It is proposed that a combination of non-digestible oligosaccharides that can be fermented throughout all sections of the gastrointestinal tract including the large intestine may result in prolonged prebiotic effects and prove useful as feed additives in the diets for pigs (Mosenthin and Bauer, 2000). In poultry, the role of dietary oligosaccharides is not clear.

Prebiotic effects

Those who look for the prebiotic effect of oligosaccharides often report a change in the number and make-up of the gut microflora indicative of a beneficial effect (Spring *et al.*, 2000), whereas those who investigate the performance-related parameters argue that an elevated level of oligosaccharides in poultry diets increases fluid retention, hydrogen production and diarrhoea, leading to impaired utilisation of nutrients (Saini, 1989; Coon *et al.*, 1990).

Iji and Tivey (1998) reported that the effect of natural raffinose series oligosaccharides (raffinose, stachyose, verbascose and ajugose) is different from the effects of synthetic (industrial) products on the productivity of broiler chickens. There is evidence of negative effects on animal health and productivity from the use of raffinose series oligosaccharides, but beneficial effects from the use of synthetic oligosaccharides.

The digestion of raffinose series oligosaccharides may also alter the osmotic differences between the mucosa and plasma, and this may account for diarrhoea observed in animals on diets with high levels of legume seeds (Saini *et al.*, 1989).

In weaning piglets, Fledderus (2005) observed that the inclusion of soya oligosaccharides from soya soluble as a replacement for corn starch caused intestinal disturbance as indicated by more chyme production and higher microbial activity in the gut.

Soya oligosaccharides increased microbial activities as indicated by the increased ATP and VFA contents. Microbial activities increased the formation of harmful metabolites such as biogenic amines. Elevated biogenic amine production in the gut might lead to the alteration of local and systemic animal physiological functions.

Inclusion of oligosaccharides

Fledderus (2005) determined the effect of the inclusion of soya oligosaccharides in the diet for weaning piglets on microflora composition in the ileal digesta.

The addition of soya oligosaccharides had no significant effect on microflora composition, the number and type of bacteria per gram chyme. However, on a DM basis, more bacteria were produced in piglets fed the soya oligosaccharides supplemented feed because of the increased total chyme production. Due to the lack of a specific effect on beneficial bacterial populations, little potential is exhibited to exploit soya oligosaccharides as an integrated dietary pre-biotic.

In weaning piglets, the effect of natural soya oligosaccharides on microbiota composition may be different from synthetic oligosaccharides. It was observed that a diet based on SBM providing 1% soya stachyose and raffinose did not significantly affect intestinal bacterial numbers in weaning piglets compared to the control diet (Zhang *et al.*, 2003). Supplementation of 1% pure stachyose stimulated Lactobacillus spp., however, the addition of 2% pure stachyose significantly reduced intestinal *lactobacteria* and *bifidobacteria*.

Natural and synthetic stachyose

The different responses between natural and synthetic stachyose may be explained by the difference in fermentation kinetics (Smiricky-Tjardes *et al.*, 2003; Lan *et al.*, 2005). Smiricky-Tjardes *et al.* (2003a,b) observed that synthetic raffinose and stachyose were more rapidly fermented *in vitro* than soya solubles that contributed the same amount of raffinose and stachyose. *In vitro* fermentation with swine faecal microflora showed a higher fermentation rate for soya soluble compared with other oligosaccharides (fructo-, manno- and xylo-oligosaccharides).

In growing pigs, Smiricky-Tjardes *et al.* (2003b) suggested that dietary galactooligosaccharides, including soya solubles, might be used as prebiotics as they increased faecal *bifidobacteria* and *Lactobacillus* population, although the addition of soya soluble to a basal diet reduced ileal and total tract DM, OM and N digestibility. It is generally accepted that high levels of soya oligosaccharides, in particular stachyose and raffinose, can cause intestinal disorders in weaning piglets.

Pigs do not have endogenous enzymes capable of digesting certain oligosaccharides, such as stachyose and raffinose (Veldman *et al.*, 1993). The fermentation of oligosaccharides in the intestine can cause flatulence and diarrhoea (Zhang *et al.*, 2003).

Zhang *et al.* (2003) observed that supplementation of stachyose at an inclusion level of 1 and 2% reduced the growth rate of weanling piglets. The recommended level of soya bean galactooligosaccharides (stachyose and raffinose) in the weaning piglets' diet is not to exceed 1% when SBM is used as a main protein source. Furthermore, diarrhoea incidences were highest in the SBM diet, lowest in the control diet and intermediate in the stachyose diet.

Similar results were observed by Fledderus (2005), that is, an SBM-based diet induced the highest incidence of diarrhoea (six days) compared with a positive control diet (3,6 days) and an SPC-based diet (2,4 days) in weaning piglets. Total replacement of SBM with SPC as a protein source reduced diarrhoea incidence and improved growth performance.

Broiler performance

In broilers, it was observed that the concentration of free sugars in the supernatant of the digesta from the distal small intestine demonstrated several significant negative correlations with performance (Irish and Balnave, 1993). Weight gain and feed intake were significantly correlated with the concentration of stachyose, raffinose and sucrose; feed conversion with the concentration of stachyose and raffinose. No such correlations with performance were found with the concentration of these sugars in the digesta from the proximal small intestine.

The authors suggested that the oligosaccharides present in SBM may play some part in the poor performance of broilers fed SBM-based diets. A high concentration of oligosaccharides in the small intestine produces an osmotic effect, leading to fluid retention and an increased rate of passage that could adversely affect the absorption of nutrients.

Effect of ethanol extraction

Raw soya beans contain high amounts of anti-nutritional factors (ANFs) and need to be properly processed before their applications in animal feed. The nutritional value and quality of soya products differ due to differences in processing technology. The ANF in soya beans can be divided into heat-labile and heat-stable components. The most important heat-labile ANFs are trypsin inhibitors and lectins, which can reduce the digestibility and utilisation of nutrients.

The most important heat-stable ANFs are proteins exhibiting antigenic effects (soya antigens) and oligosaccharides. In the processing of SBM, only heat-labile soya ANF is inactivated. SBM therefore still contains a high amount of heat-stable ANFs, e.g., soya antigens, oligosaccharides and soluble NSP. This limits the application of SBM in the feed for young animals, such as weaning piglets, as they are very sensitive to soya ANF.

The ethanol/water extract process allows the removal of soya oligosaccharides and soluble NSP. Ethanol extraction achieves a 90% reduction in the oligosaccharides present in SBM (Veldman *et al.*, 1993). Simultaneously glycinin and [beta]-conglycinin, the two most important storage proteins in soya, are denatured and eliminated their antigenic properties.

In weaning piglets, the inclusion of SBM can cause intestinal disorders, increase the risk of diarrhoea occurrences, and reduce the growth performance of the newly weaned piglets (Zhang *et al.*, 2003). The negative effect of SBM in piglets is mainly caused by the heat-stable ANFs, i.e., soya antigens, oligosaccharides and soluble NSP.

It was observed that ethanol extraction improved nitrogen and amino acid digestibility, plasma lysine concentration, villus height, feed intake, growth rate and feed efficiency.

Conclusion

Soya beans contain a high concentration of carbohydrates, consisting predominantly of NSP and free sugars, such as oligosaccharides. Oligosaccharides and approximately 45% of the NSP are soluble. These soluble components are one of the main factors responsible for the anti-nutritional effect of soya beans. The ethanol/water extraction process removes these soluble parts from soya efficiently and yields a high-quality soya protein product.

This article has been shortened for publication in *Oilseeds Focus*. For references and to read the full article, visit *www.preparedfoods.com/articles/107443-reviewing-soybean-carbohydrates*.

Regenerative agriculture at the forefront

By Hugo Lochner, Plaas Media

Bayer recently shared its vision for producers of the future during the company's Crop Science Innovation Summit hosted in New York. The summit offered a glimpse into the future of agriculture and how Bayer contributes through innovation to support sustainable food production.

Rodrigo Santos, president of Bayer Crop Science and board member of Bayer AG.

Frank Terhorst, head of strategy and sustainability at Bayer Crop Science.

Dr Robert Reiter, head of research and development at Bayer Crop Science.

Food security and climate change

Rodrigo Santos, president of Bayer Crop Science and board member of Bayer AG, said two of the most recognised global challenges are food security and climate change. "By 2050, climate change is projected to reduce producers' harvest yields by 17%, and on top of that there will be 20% less land available for farming. By 2050, we need to feed an additional 2,2 billion people.

"Combined with the impact of climate change, we need to increase food and feed output by 50% to accommodate the higher demand and shifting diets. That is where regenerative agriculture comes in. We believe regenerative agriculture is the future of this industry."

Bayer defines regenerative agriculture as increasing food production, farm incomes and resilience in a changing climate while renewing nature. This includes improved productivity, the social and economic well-being of producers and communities, conservation of water, mitigation of climate change, improved soil health, and the preservation and restoration of biodiversity.

Doubling accessible markets

Santos said Bayer can deliver regenerative agriculture at scale because of its global presence and pipeline innovation. "Right now, with our seeds and trade technologies alone, Bayer reaches more than 340 million acres (138 million hectares) and in the coming years we have the ability to expand to more than 400 million acres (162 million hectares)."

The move to regenerative agriculture is going to drive Bayer's growth, he said. "Our accessible markets have a value of more than €100 billion globally. By using the systems to unlock new opportunities, our market opportunities could reach over €200 billion, doubling our accessible markets of today."

The company identified growth potential in segments such as crop fertility, biologicals, biofuels, carbon farming, precision application services, as well as digital platforms and marketplaces, all of which are serving the needs of agriculture, said Santos.

Embrace climate-smart choices

Frank Terhorst, head of strategy and sustainability at Bayer Crop Science, said the company wants producers to embrace climate-smart choices and the best way of doing that is to make them both easy, convenient and better to adopt.

One of Bayer's four strategic priorities is to clearly define, shape and scale regenerative agriculture. "As we drive our business our 30:30:100 sustainability commitment by 2030 will manifest naturally. These commitments represent a 30% reduction in greenhouse gas emissions for producers, a 30% reduction in the environmental impact of crop protection products, and enabling 100 million smallholder producers to grow. In addition, with agriculture using up to 70% of our global freshwater withdrawals, we have our new commitment helping producers improve water use per kilogram of rice produced by 25% also by 2030."

Investing in R&D

Dr Robert Reiter, head of research and development (R&D) at Bayer Crop Science, said Bayer can envision the farms of the future because they are already building them. Bayer invests more than €2,6 billion annually in R&D. This investment continues to advance an innovative pipeline with an estimated peak sales potential of more than €30 billion, thereby promoting regenerative agricultural practices and enabling producers to support both global food security and mitigation of climate change.

For more information, visit *www.bayer.com*.

Trespassing:
The first step to serious rural crime

By Hans-Jurie Moolman, Moolman & Pienaar Incorporated

South Africa has seen a sharp increase in farm attacks in recent years. Responding to these crimes in a legal, professional and efficient manner requires thorough and properly co-ordinated efforts. This applies to situations where criminals are still planning or preparing for a large-scale violent attack, and they or others trespass on a target area in a bid to spy and gather information.

Farm attacks or attempted farm attacks are more often than not accompanied by serious crimes such as murder, assault and rape. In performing a logical and chronological analysis of any farm attack, you'll notice that trespassing is the first offence criminals have to commit in order to engage in serious crime.

Secure property boundaries

Timely and effective action against trespassers can be used to secure the boundaries of your property in a figurative sense. To have more control over who has access to the farm, it is imperative that the identity of farm dwellers or visitors to a farm must be known. This will allow for easier and quicker identification of strangers on the farm as well as action in the form of laying criminal charges against them.

According to the *Trespass Act, 1959 (Act 6 of 1959)*, permission must be obtained from the following people before accessing land or premises:

- The legal occupier of the land or building or part of the building.
- The owner of, or person in charge of, land or a building or part of a building that is not legally occupied by another person.

People who access such land or buildings or part of a building without permission are guilty of an offence, unless he/she has a lawful reason for entering the building or for being on that land.

In addition to controlling access to farms, it is advisable to put up a notice at all the access gates to a farm stating in the local language that:

- The right of access to the farm or any part of it is reserved and that violators will be prosecuted.
- Only existing access gates to or from the farm may be used to enter the farm.

Farm dwellers must be made aware of these measures, and a deliberate effort to promote safety must serve as motivation.

Complaints regarding trespassing

If people who do not have permission to be on the farm are seen or their presence reported, it is recommended that a complaint of trespassing be lodged against them with the South African Police Service.

In the event that a complaint is lodged against trespassers, it is important to bear in mind that the complainant must be able to legally confirm that the offender did not have permission to be on the farm. Given the definition of this offence, it is clear that the complaint may only be filed by the owner or a legal occupier of that land.

Role of the state

It is the duty of the state to prove, beyond a reasonable doubt, the criminal charge against the accused. The state must prove that the person or institution that filed the complaint of trespassing is indeed the owner or legal occupier.

Therefore, and to promote swift action against an offender, it is strongly recommended that the following documentation or certified copies thereof be kept at hand:

- A copy of the title deed of the farm or the portion on which trespassing occurred (before lodging the complaint, there must be certainty as to who the registered owner on the title deed is).
- In the event that the complainant is a company, trust or close corporation, a legal resolution authorising the filing of complaints on behalf of the entity and authorising the person to file the complaint(s) and make statements on behalf of the particular entity.
- If the complainant is not the owner, a copy of the legal occupier's rental agreement or any other proof that the person or institution in question legally occupies the land.

This documentation must accompany the complainant when a complaint is filed.

A last thought

Criminals tend to avoid environments characterised by stringent control and a high risk of prosecution. Establishing such an environment requires deliberate lawful action, and should be the goal of every landowner.

For more information, phone the author on 018 297 8799 or send an email to hj@mmlaw.co.za.

Labour audit without hassle

By Tammerin van Vuuren, paralegal, LWO Employers Organisation

The business environment in South Africa is highly regulated where labour legislation is concerned. This puts employers under increasing pressure, specifically in terms of the farming enterprise's profitability and sustainability.

The following is a short checklist that will assist employers in navigating the requirements set by labour legislation.

Important registrations

- Are you registered with the Compensation Fund?
- Are you registered with the Unemployment Insurance Fund?

Assess employment contracts

- Does each employee have an employment contract that complies with relevant labour legislation? The employment contract is the most important document in the workplace and is the foundation on which the employment relationship rests.
- Are your employment contracts fixed term or permanent and are they in line with legislation? Remember that it is illegal to disguise what is actually permanent employment in the form of a fixed-term employment contract.

Key documentation

- Does each employee receive a salary slip that complies with labour legislation?
- Is there an attendance register and a record of hours worked?
- Are there legal posters displayed in the workplace, specifically the *Basic Conditions of Employment Act, 1997 (Act 75 of 1997)*, *Employment Equity Act, 1998 (Act 55 of 1998)*, and *Occupational Health and Safety Act, 1993 (Act 85 of 1993)*?
- Does each employee have a personnel file containing the following information: employment contract, leave forms, salary slips, disciplinary record, identity document, personal details and the like?

Workplace discipline

- Is there an up-to-date, relevant disciplinary code in the workplace that employees are aware of and understand? The disciplinary code is a guideline that employers can make use of to identify the appropriate sanction for specific offences.
- In terms of the rule(s) regarding a specific topic, are there clear policies in place that employees can follow? Policies define the employer's own rules and must be fair. Typical policies include those for smoking, mobile phone usage and hygiene.
- Are there clear procedures in place that employees can follow if a specific incident occurs? This typically includes appeal and grievance procedures.

Other requirements

- Are you paying at least the minimum wage?
- Are you a designated employer in terms of the *Employment Equity Act* and do you meet the relevant requirements?
- Do you comply with the requirements of the *Occupational Health and Safety Act*?
- If your employees belong to a trade union, do you have a recognition agreement in place?

Workplace inspections

One of the key mandates of the Department of Employment and Labour is the enforcement of labour legislation. The department also conducts regular inspections to ensure compliance. Labour inspectors do not need a warrant or notice to enter the workplace and can do so at any reasonable time. They will hand over a letter informing the employer of the investigation the inspector will conduct to make sure the business is compliant. However, an inspector cannot enter a household for inspection without the permission of the owner or a Labour Court order.

In terms of Section 66 of the *Basic Conditions of Employment Act*, an inspection by the labour inspector will entail:

- Collecting information and evidence from employers and employees.
- Collecting copies of any records or documentation.
- Inspecting the premises.

Aspects pertaining to security

People sometimes falsely impersonate labour inspectors to gain access to premises, which raises safety concerns among producers. If a person says he or she is a labour inspector, insist on positive identification and verify this information before giving the person access to the premises. Also remember that the inspector may not charge a fee for the inspection, investigation, advice or any assistance.

The Department of Employment and Labour does not make use of third parties to carry out an inspection on their behalf. Inspectors may also not sell posters, products or information.

A final thought

Compliance with labour legislation is non-negotiable and employers risk heavy fines and even imprisonment in cases of non-compliance. Employers must stay up to date with, and comply with, applicable labour legislation.

The LWO Employers Organisation assists employers to comply with labour law, and to use it to their advantage to protect their business. As a registered employers' organisation with the Department of Employment and Labour, the LWO has the right to represent members at the CCMA. Contact the LWO on 086 110 1828 or send an email to tammerin@lwo.co.za.

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