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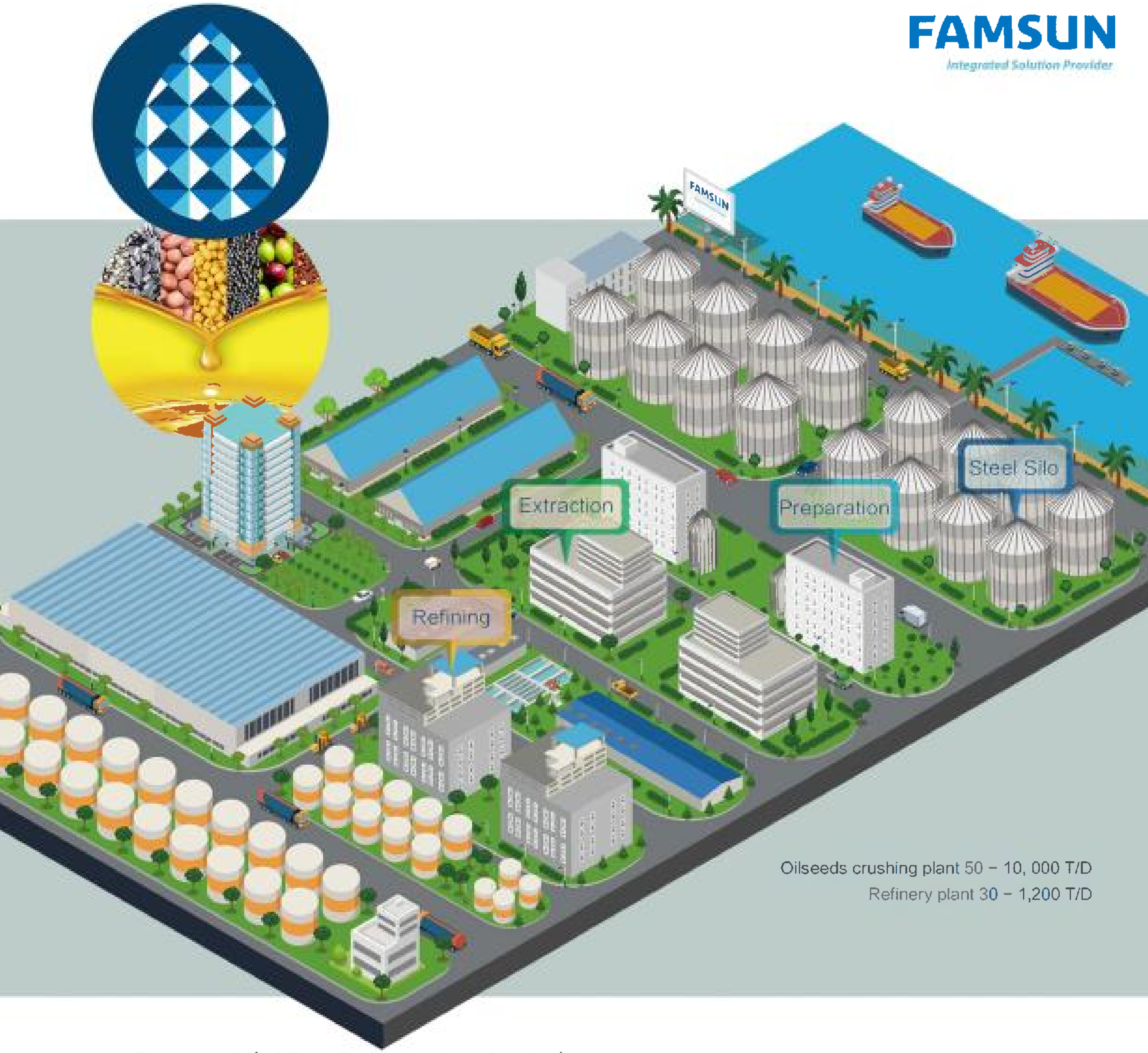

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The impact of COVID-19 **on the South African agricultural sector**

By Prof Ferdi Meyer, managing director, Bureau for Food and Agricultural Policy

A few months ago, if anybody suggested the possibility of an international viral pandemic during a typical strategic planning session of a company, they would have been laughed out of the meeting room – and it would have been an actual room with people physically present.

On 27 March this year, the country went into what was initially envisaged to be a 21-day lockdown period, which implied that all South Africans had to stay home. This lockdown period was eventually extended.

In his address on 23 April, president Cyril Ramaphosa announced an approach where the re-opening of the economy would be managed based on five alert levels. The country moved to level 4 on 1 May, which brought some relief to the agricultural sector through the resumption of wine, wool and cotton exports. However, the drop in food consumption levels mainly due to the continued lockdown of fast food outlets and restaurants, is cause for major concern.

Dwindling demand

The impact of job losses and overall economic hardship still has to filter through the system and even if the country swiftly moves to level 3 or even level 2, demand will remain weak for the third and fourth quarters of 2020. Cold storage space, especially for products such as chicken and beef, is filling rapidly and the first companies are hinting at cutting back on production levels.

Consequently, the Bureau for Food and Agricultural Policy has already reduced the projected feed demand figures for grains and oilseeds for 2020. Major uncertainty remains regarding the length and depth of COVID-19's impact on the agricultural sector, especially since current indications all point to the fact that coronavirus infections in South Africa will still increase considerably and are only expected to peak in September.

Disruptions in the food system

It is apparent that government aims to follow a flexible and responsive model where restrictions on some economic activities, especially those with a low risk of transmission, will gradually be relaxed. However, if there are signs that infection rates are starting to accelerate again, restrictions will be tightened. When that happens, disruptions in the food system will not be caused by lockdown restrictions, but rather by the closing of food processing plants and distribution and retail facilities when abrupt localised outbreaks of COVID-19 occur.

> "While supply chain logistics may, in the event of a prolonged outbreak, start to influence the consistency of availability of these products to South Africa, global supply is not a concern.

We have seen a number of these disruptions in other parts of the world, especially in meat processing plants in the United States.

Effect on imports and exports

Although global stock levels are generally very high, food supply chains and food consumption patterns are already affected. Overall, South Africa is a surplus producer of food and the value of South Africa's food exports exceeds imports by a significant margin. In terms of imports, the world market is well stocked in all food items. Since mid March, any periodic shortfalls largely occurred due to logistical disruptions caused by lockdowns and restrictions on the movement of goods. This is mainly the case for specific food items that are typically imported from affected regions in the world market.

On the export side, disruptions due to logistical problems or restrictions on the movement of goods is having a negative economic impact on South African producers, agribusinesses and exporters. For example, in April there were significant delays with a number of cargo ships that were supposed to load citrus and other fruit for export.

The record citrus crop is currently at its peak harvesting period and any bottlenecks in exports can cause major financial loses, as agribusinesses will face lower prices when products destined for export are diverted into the local market.

The most significant contributor to South Africa's food import bill is highly processed, non-perishable products, which would typically include vegetable oils, sugar, coffee, tea and alcohol. While supply chain logistics may, in the event of a prolonged outbreak, start to influence the consistency of availability of these products to South Africa, global supply is not a concern.

South Africa finds itself at a relatively early stage in the epidemiological cycle. There are widely differing views on the appropriate balance between containing the spread of the virus as far as possible to flatten the curve and improve the readiness of the health system, versus the negative impact of lockdown restrictions on economic activity.

Although we know that the world economy will eventually recover, life as we know it will not be the same.

For enquiries, phone Prof Ferdi Meyer on 012 420 4583 or send an email to ferdi@bfap.co.za.

A year to remember or one to forget?

The impact of the coronavirus has changed the business environment globally – perhaps even more so in South Africa, with our country having implemented some of the strictest lockdown regulations in the world.

Statistics South Africa's second impact survey, which was a business response from mid to late April, indicated that, just a few weeks into the lockdown, a third of firms had started laying off staff, while 25% had decreased working hours. Sadly, 10% of businesses had also permanently ceased operations by the time I wrote this article. Sectors most affected by business closures were construction (14%), community, social and personal services (12%), and agriculture, hunting, forestry and fishing (12%).

When the lockdown was imposed, more than half of businesses indicated that they could not survive without turnover for one to three months. The restaurant industry, in particular, was on the brink of collapse. Escalating unemployment became another harsh reality, with an estimated four million additional job losses.

Unfortunately, by the time you read this issue of *Oilseeds Focus*, these statistics will be outdated and the devastating effect of the lockdown on our economy may be even greater.

Counting our blessings

The agricultural industry, which was classified as an essential service, can be incredibly grateful that it was able to operate. Here, government must be commended for its assistance in allowing and enabling the sector to continue, with minor exceptions.

Despite many challenges, a maize crop of 15,22 million tons is expected this season. This is exceptional given the ten-year average of 11,97 million tons and is second only to 2017, when a crop of 16,82 million tons was reported.

The soya bean crop is expected at 1,29 million tons. The ten-year average is 949 616 tons, and this season's crop is only surpassed in size by the 2017 and 2018 seasons. The Free State has shown encouraging growth of 37% in production and is the largest production region of soya beans this season. With carryover stock, this crop should allow for processing of 1,45 million tons in 2020/21, thus continuously increasing South Africa's strides toward self-sufficiency in soybean meal.

The sunflower crop, which is expected to be around 731 210 tons, is also encouraging, while groundnuts have made a remarkable recovery from the crop failure of last year, which produced less than 20 000 tons. In comparison, this season's crop of 62 470 tons should bring great relief to the industry.

Looking forward

The impact of the coronavirus will be felt for a long time. Since the lockdown began, Business Unity South Africa has suggested that instead of begrudgingly opening the economy with a long list of prescribed goods, government should supply a short list of exclusions. Only time will tell what will happen. For the sake of all South Africans, let us hope that logic prevails.

Enjoy this edition of *Oilseeds Focus*.

Dr Erhard Briedenhann

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

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NEWS

Fava beans could be a new protein alternative

Danish researchers have developed a new processing method that may leverage fava beans as an environmentally friendly alternative to soya. Demand for plant-based alternatives to meat and dairy products continues to rise. Data from Mordor Intelligence reveals that soya protein has the highest market share. However, there are some serious red flags over the environmental impact of soya cultivation, researchers from the University of Copenhagen's Department of Food Science have warned.

"Many consumers are crying out for alternatives to soya, a crop that places great strain on the environment," says Iben Lykke Petersen, an assistant professor at the University of Copenhagen's Department of Food Science, and one of the researchers behind the new study published in the journal Foods. "This prompted us to find a method of processing fava beans in such a way that allows us to produce a concentrated protein powder. This is excellent news for the climate."

In order to concentrate the fava bean protein and remove substances that would inhibit digestion, the researchers used a method known as 'wet fraction'. This allows nutritious fava bean proteins to be more readily absorbed when consumed. – *Food Navigator*

South Australia lifts ban on GM crops

After 16 years and multiple attempts, South Australia is lifting its ban on genetically modified (GM) crops beginning next season. The decision to lift the ban followed an independent review that concluded that the monetary loss since 2004 for just canola crops was estimated to be $33 million.

The decision is being lauded by Grain Producers South Australia, the state's leading lobby group for grain growers, which said there is great interest in trialling GM canola varieties currently being grown across the rest of the country.

The legislation allows for councils to remain GM-free; however, to do so a council has a six-month window in which to apply. Kangaroo Island will maintain the ban because of export market demands. However, concerns remain that this might result in a patchwork across the state with scattered councils maintaining the ban, which would create difficulties across the sector.
– *Oilseed and Grain*

Cas-CLOVER: An alternative to CRISPR-Cas9

CRISPR-Cas9 has been the most utilised gene editing system used for genetic improvement of plants, animals, and other organisms. However, a new gene editing technology called Cas-CLOVER was presented by *Genetic Engineering and Biotechnology News* (GEN) in April this year.

Cas-CLOVER, developed by Hera BioLabs, is functionally similar to CRISPR-Cas9, but uses a different nuclease protein called Clo51. Thus, Cas-CLOVER is a fusion protein that comprises a nuclease-inactivated Cas9 protein fused to the Clo51 endonuclease. Compared to CRISPR-Cas9, it demonstrates higher fidelity with no detectable off-targets while maintaining robust editing efficiency.
– *ISAAA*

Argentine soya bean crush to rise

Soya bean crushing in Argentina is expected to pick up by 3,4% in the 2020/21 marketing year as strong competition in the global soya bean market will drive more beans through its domestic grind, boosting soya oil and soya meal exports.

A total of 43 million tons of Argentina's expected 53,5 million ton crop will be crushed domestically, taking up just over 80% of the total output, while soya bean exports are expected to fall to 6,5 million tons. That compares to a domestic crush of 41,6 million tons for the world's largest meal and oil exporter in the current marketing year, with bean exports at eight million tons versus a smaller crop of 51 million tons.

Argentina bean exports are projected to decline in the face of strong competition from the United States and Brazil and growing domestic crush. – *AgriCensus*

Symposium to tackle new era in soya marketing

Taking place from 5 to 6 November, the second International Symposium Soy & Strategic Marketing will involve soya market updates, case studies on successful product introductions, and the latest on soya health claims in Europe.

"A more focused product positioning is needed to boost sales. Research has shown that the presence of the name 'soy' on a label can induce negative ratings of taste, but favourable ratings regarding nutritive value. For certain consumer segments ingredient labelling may have more favourable consequences, while for others the opposite is true. Therefore, a good segmentation and positioning of the product is essential," say the organisers.

More information is available at *www.soyconference.com*.
– *Food Navigator*

Slaughterhouse bottlenecks affect grain farmers

The abrupt halting of the United States (US) economy when restaurants closed during the COVID-19 lockdown, was a huge blow for meatpackers and food processors with a primary focus on food service. As a result of the forced closure of several US slaughterhouses, meat supply at grocery stores then came under pressure.

Animals and feed ingredients are plentiful in the US, but the slaughterhouse bottleneck caused pain for producers of both, as well as for consumers. In April, approximately 11,3 million cattle and calves were on feed for the slaughter market in feedlots with a capacity of at least 1 000 heads – down 5,5% from the April 2019 inventory.

Feed figures also declined, which could increase headaches for US maize and soya bean growers. When meat plants reopen, there is a high likelihood that they might operate at less than full capacity to implement and maintain safety standards, which could slow the recovery in production. – *Reuters*

Gene may assist with FHB-resistant wheat

Researchers from the United States Department of Agriculture's Agricultural Research Service (USDA ARS) and colleagues from Shandong Agricultural University in China, have discovered a gene that can be used in the development of wheat varieties with more resistance to *Fusarium* head blight (FHB).

FHB is a major threat to wheat crops worldwide. It shrivels grain and can significantly decrease harvests of wheat and barley. Worse, the toxins released by the fungus *Fusarium graminearum*, a growing problem in the breadbaskets of Europe, North America, and China, remain in grain intended for food.

The researchers published their discovery and the cloning of the gene, known as Fhb7, in the journal Science. Fhb7 was found in *Thinopyrum* wheatgrass, a wild relative of wheat previously used to develop varieties of wheat with beneficial traits, such as rust resistance and drought tolerance. The research team found that the gene effectively reduces FHB by detoxifying the mycotoxins secreted by the pathogen. The gene also confers resistance to crown rot, a wheat disease caused by a related pathogen. – *ISAAA*

US expects more soya beans for 2020/21

The 2020/21 US soya bean crop is projected at 4,125 billion bushels, up 568 million from last year. Total US oilseed production for 2020/21 is forecast at 123,2 million tons, up 16,1 million from 2019/20 mainly due to higher soya bean production. Production forecasts are also higher for sunflower seed, peanuts and cottonseed. Canola production is forecast lower on a reduced yield.

With higher global soya bean import demand for 2020/21 led by expected gains for China, the US export share is expected to rise to 34% from the 2019/20 record low of 30%.

The global oilseeds outlook for 2020/21 includes larger supplies with lower beginning stocks offset by record production; however, ending stocks are expected to decline. Global oilseed production for 2020/21 is projected at a record 605,9 million tons, up 30,7 million from 2019/20, mainly due to higher soya bean production. – *AgWeb*

Canola council not giving up on Chinese market

The Canola Council of Canada remains committed to regaining full access to the Chinese market for Canada's canola seed. In March 2019, permits allowing Canada's two biggest grain companies – Richardson International and Viterra – to export canola seed to China were suspended by the Chinese government.

China claimed Canadian canola seed was contaminated with blackleg disease and weed seeds, an allegation the Canadian Food Inspection Agency claimed had no merit. It is widely believed China's actions were designed to punish Canada for its December 2018 arrest of Meng Wanzhou, vice-president of Chinese technology firm Huawei, at the United States' request.

China had been Canada's best canola seed customer, having imported 4,8 million tons worth $2,7 billion in 2017/18. Since then canola seed exports to China are roughly 30% of what they used to be. While seed sales have suffered, Canada continues to export canola oil and meal to China. – *Manitoba Co-Operator*

China steps up US soya bean buying

China is stepping up purchases of soya beans from the Unites States (US) as Brazilian sales start to wane and the Asian nation seeks to meet its pledges under the trade deal with Washington. State-run buyers purchased more than 20 cargoes, or over one million metric tons, of American soya beans in May. The beans were bought using tariff waivers previously issued. A purchase of 136 000 tons was reported by the US government.

Top trade negotiators from both nations pledged to create favourable conditions for the implementation of the bilateral trade deal and to co-operate on the economy and public health, according to a statement from the Chinese Ministry of Commerce.

However, the Phase One trade deal could be on shaky ground. China may weigh voiding the agreement after US criticism of the country's handling of the coronavirus triggered anger among trade insiders.

China pledged to buy $36,5 billion in American agricultural goods, but the pandemic that is thought to have originated in the city of Wuhan has delayed the pace of purchases. While the nation has picked up a wide range of commodities from sorghum and wheat to corn and pork, sales of soya beans, the poster child for the trade war, have now started to accelerate. – *Bloomberg*


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Sclerotinia in soya beans: Know your enemy

By Nico Barnard, agronomist, Pannar Seed

Sclerotinia, a disease found in crops across the globe, can cause a 0,25t/ha loss for every 10% of plants infected. It occurs in 64 different plant families and in over 400 plant species, including some well-known weeds. It can infect almost all annual broadleaf crops.

It is essential that anyone wishing to minimise damage, knows and understands the disease. As there is no single management regime that can control it, an integrated management plan is the only way to limit the impact of the disease.

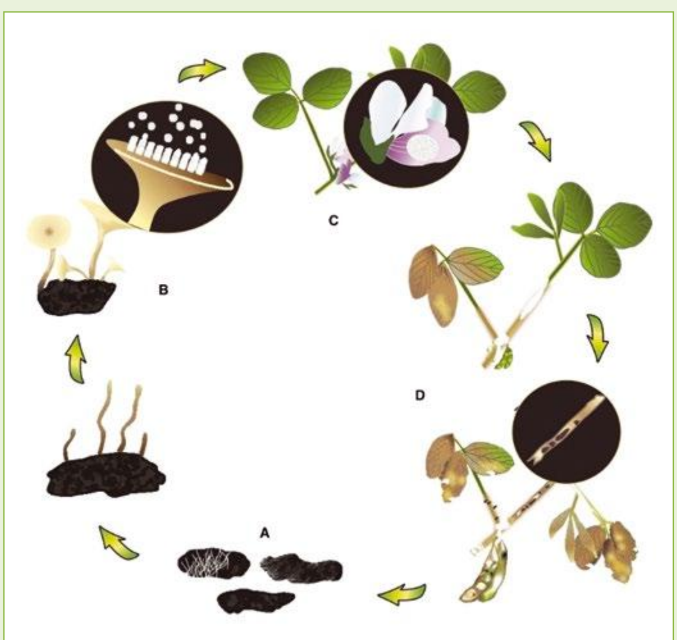
Life cycle of sclerotinia in soya beans

A: Sclerotinia can survive as undefined black structures, known as sclerotia, in the soil for seven to ten years. The inside is cream- to salmon-coloured.

B: When weather conditions are favourable, the sclerotia germinate and small mushroom-like structures, known as apothecia, start to grow upwards. In order for them to develop, these apothecia need wet soil, humidity higher than 75% and relatively cool soil temperatures of 12 to 24°C. Sclerotia buried as deep as 5cm can still produce apothecia, but most are formed on sclerotia present just below the soil surface. Conditions must remain favourable for several days in order for apothecia to reach maturity.

Apothecia are small, funnel-shaped mushrooms that are light- to salmon-coloured with a diameter of 2 to 5mm. Once conditions are ideal and apothecia have matured, thousands of spores are released up to 16cm high into the air, where air currents spread it over larger distances.

Figure 1: The life cycle of sclerotinia.



C: Sclerotinia spores germinate on the flowers of soya beans at air temperatures below 28°C. The flowers must be wet, either from heavy dew, mist or rain, for at least three consecutive mornings for spores to germinate (keep in mind that spores can germinate on any dead plant material). The soft petals are energy-rich and the ideal medium for the spores to germinate on.

D: Sclerotinia that is growing, releases oxalic acid which kills the flower; the sclerotinia then penetrates even deeper into the flower. This process is repeated until the leaf axil is reached via the flower stalk. Infection spreads from the leaf axil to the stems, which then start to die in an upward manner. Leaves that die and wither are the first symptom, which is usually only observed two to three weeks after the spores have infected the flowers.

The sclerotinia grows actively in the maturing soya bean plant and forms new sclerotia, which resemble mouse droppings. During the harvesting process the sclerotia are distributed by the combine harvester, allowing a new generation to spread. Infection can only spread from one plant to the next when leaf stalks or stems touch and sclerotinia then grow from plant to plant.

The best way to control the disease is by preventing the sclerotia from germinating and forming apothecia, or by protecting the flowers and preventing spores from germinating on the flower. Nothing can be done about plants that are already infected as corrective spraying cannot be applied.

Sclerotinia control

Unfortunately, all yield-enhancing practices contribute to the occurrence of sclerotinia. The more leaves a soya bean field can produce, the better the yield. There are two options for managing sclerotinia:

- Option 1 is to open up the leaf canopy to allow the soil to dry out faster and to keep the plants as dry as possible. This can be achieved by using wider rows (1,1 to 1,5m). Wider rows mean lower yields if sclerotinia does not occur. The prevalence of sclerotinia in wider rows is normally lower and yield losses are limited. This practice

This year, the Animal Feed Manufacturers Association (AFMA) is celebrating 75 years of service to its members and the entire grains and oilseeds, livestock, and poultry value chains.

The core reason for the establishment of AFMA in 1945 was the need for a scientific and unified voice for the animal feed manufacturing industry. During the past 75 years, AFMA has established and positioned itself as a leading partner across the entire animal feeds value chain.

AFMA CELEBRATES 75 YEARS

1945-2020

Today, AFMA is known for the strategic role it plays across local and international livestock and related animal feed industries.

AFMA currently consists of a network of 163 members based in South Africa and the SADC region. A recently completed study found that AFMA members produces 61% (approximately 7 000 000 tons) of South Africa's total feed production of 11 500 000 tons.

AFMA members are governed by the Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947, Act No. 36 of 1947 regulated by the Department of Agriculture, Land Reform and Rural Development (DALRRD). However, as early as 2007 members had already agreed to the notion of self-regulation under the AFMA Code of Conduct, which ensures that all members strictly adhere to legal and regulatory requirements, and implement the necessary controls to ensure the production of **safe feed for safe food**. Compliance with the Code is a prerequisite for AFMA membership.

In addition, AFMA plays a proactive role in promoting science-based solutions and information sharing for all role players involved in the supply of safe animal proteins such as poultry, beef, pork, dairy products and game meat.

Internationally, AFMA represents the South African feed industry on the International Feed Industry Federation (IFIF) Board, the IFIF Regulatory Committee and the International Feed Regulator's Meeting (IFRM).

AFMA congratulates VEEPLAAS on celebrating its first 10 years.

We look forward to many more years of factual and objective reporting on the livestock industry.

75 1945-2020 AFMA

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is recommended in areas in which sclerotinia is common.

- Option 2 is to plant upright-growing cultivars later in the season to keep rows from closing. This practice can restrict yields and lead to low pod height that, in turn, can greatly complicate the harvesting process.

Chemical control

Here the goal is to prevent the spores from germinating on the flowers. For control to be successful, the flowers must be sprayed. This process is made more difficult in a soya bean field of which the canopy has already closed.

Timing is therefore critical; spraying must be done when the climate is optimal for spore release and while the soya bean plants are flowering. Large volumes of water must be used to wash the chemical into each leaf axil carrying flowers. The money put towards a preventative spray programme will be wasted if the timing is off.

It is very difficult to predict climate conditions accurately and forecast models are not really helpful. The main disadvantage of chemical control is that only the sprayed flowers are protected; those opening a week later are not protected and can be infected, thus negating the entire process.

Crop rotation

Using soya bean in rotation with another non-host crop reduces the incidence of sclerotinia. Non-host crops include grasses such as maize, sorghum and forage grasses. In areas where sclerotinia is commonly found, it is recommended to plant soya bean only every third or fourth season; this allows sclerotia to germinate in the soil and produce spores while no host is present.

Sclerotia in soya bean seed.

If cover crops are part of your crop rotation, do not include broadleaf crops in the mix as it can serve as a host and help sclerotinia to take hold. Radishes, turnips and cabbage-type crops are particularly sensitive to sclerotinia and in such instances it is best to use only grasses as a cover crop.

Biological control

Biological control of the disease is still in its infancy, but the future looks very promising. The primary action is to attack the sclerotia on or in the surface layer of the soil and prevent apothecia from forming. A few products are available on the market for this and preliminary trials show that this is one of the solutions that will have a greater foothold in future. The main challenge is to increase the stability of the products, especially during seasons with challenging climatic conditions.

Tillage

Thinking that a deep cultivation will bury the sclerotia deep in the soil, is probably the first solution that comes to mind. Unfortunately sclerotia can survive underground for long periods and any subsequent cultivation will only bring the sclerotia back to the surface – the problem will simply repeat itself.

No-till, on the other hand, has been shown to be more successful and actually reduces sclerotinia outbreaks. Using a no-till system, sclerotia are left on the soil surface where, when a good crop rotation system is used, most will germinate the following season and release many spores. If no host is present, it will have no effect and disease pressure will therefore be reduced.

Weed management

There are several broadleaf weeds that act as hosts for sclerotinia. Fields should therefore be kept as clean as possible, especially during crop rotation. It is also vital to keep headlands, contours and fences free of broadleaf weeds. These weeds can act as hosts for sclerotinia, thereby maintaining the disease and increasing the source of spores in the field.

Plant date

This is one of the easiest ways to limit sclerotinia damage, but success is not

Small, light-coloured apothecia.

guaranteed. The flowering date of the entire farm can be extended over a longer period if quick-growing cultivars are planted first and longer growers later. Certain fields can therefore escape the disease if ideal climatic conditions that can promote an outbreak do occur.

Cultivar choice

There is a very small difference between different cultivars' sensitivity to sclerotinia. Under ideal climate conditions and when a specific cultivar is in bloom, airborne spores can infect and damage all cultivars.

However, cultivars have different growth habits. The more upright-growing and less-branched cultivars are usually less affected by sclerotinia, as the field has greater air flow and is usually drier. Unfortunately, these cultivars have a lower yield potential than lush cultivars with more branches.

Clean seed

Seeds that have not been adequately cleaned can serve as a source of sclerotia when planted in the field. Only use seeds purchased from a reliable source.

An integrated management practice that includes all the above management actions will greatly reduce the negative impact of sclerotinia. Regrettably, the disease will never be entirely preventable.

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Principles and practices **of the photothermal adaptability improvement in soya bean**

By Zhang Li-xin, Liu Wei, Mesfin Tsegaw, Xu Xin, Qi Yan-ping, Enoch Sapey, Liu Lu-ping, Wu Ting-ting, Sun Shi and Han Tian-fu

Flowering plants can respond to the relative length of day and night, a phenomenon defined as 'photoperiodism' (Garner and Allard, 1920). Soya bean has been used as a model plant for photoperiodism studies because of its sensitivity to photoperiod and rich genetic diversity (Owen, 1927; Heinze *et al.*, 1942; Hendricks, 1958; Coulter and Hamner, 1964).

Increasing evidence demonstrates that photoperiod affects many aspects of soya bean growth and development such as leaf senescence, pod setting, seed filling, shoot and root growth, etiolation, and stress responses besides flowering and maturity (Han *et al.*, 2006; Covington and Harmer, 2007; James *et al.*, 2008; Song *et al.*, 2015; Nico *et al.*, 2016). On the other hand, as a thermophilic crop, soya bean growth and development are also susceptible to temperature changes (Setiyono *et al.*, 2007). Therefore, responses to both photoperiod and temperature affect the growth, development, and yield formation of soya bean cultivars.

Understanding the physiological characteristics, and molecular mechanisms of photothermal responses will not only contribute to thorough know-how of the varietal differences in the adaptation climatic conditions, but will also provide a theoretical basis and valuable guidance for germplasm introduction and the breeding of soya bean and other photothermal sensitive crops.

Photoperiod response in soya bean

Soya bean is a typical short-day (SD) plant, and its flowering and maturity are strictly regulated by photoperiod (Garner and Allard, 1920, 1923, 1933; Wang *et al.*, 1956). Floral bud initiation of photoperiod-sensitive soya bean cultivars can only be induced by SD treatment (Garner and Allard, 1923; Borthwick and Parker 1938, 1939). Leaves are photoperiodic signal receptors that perceive light signals to regulate the reproductive development of soya bean (Borthwick and Parker, 1938). The age effect of leaves on flowering induction increases with the development of young leaves until they reach full size (Borthwick and Parker, 1940).

Furthermore, its perception of the length of dark plays a critical role in the photoperiod response (Borthwick and Parker, 1938; Xu *et al.*, 2015). A short exposure to light during night (night break (NB)) inhibits growth and flowering in SD plants (Thomas and Vince-Prue, 1997). When the light was applied in the middle of a dark period, the effect of NB is the largest in soya bean (Xu *et al.*, 2015).

The effect of SD treatment can be partially or completely relieved by transient light treatment in the process of the dark period, and the effect of light discontinuity depends on the light quality of the last light (Parker *et al.*, 1946; Han *et al.*, 2006; Wu *et al.*, 2006). Red light (650nm) was the most effective in inhibiting flower bud differentiation, while far-red light (730nm) was ineffective (Parker *et al.*, 1946).

Moreover, when soya bean plants are subjected to SD treatment after emergence for some days and then transferred to long-day (LD) treatment, they can form flowers first and then revert to vegetative growth at the terminal shoot apex (Han *et al.*, 1998b; Washburn and Thomas, 2000). This phenomenon is called 'reversion of flowering' (Battey and Lyndon, 1990). Jiang *et al.* (2011) found that the effect of LD was a cumulative process and increased with the duration of LD treatment. As the length of LD treatment increased, the apical meristem could be reversed to produce vegetative organs. Therefore, the effect of SD can be partially or completely relieved by the continuous LD treatment in soya bean (Han *et al.*, 1998b; Wu *et al.*, 2006).

It was found that the photoperiodic response also existed in the post-flowering stages (Han *et al.*, 1995, 1996; Han and Wang, 1996). When the soya bean plants were subjected to LD treatment after flowering, the number of seeds increased with prolonged time of LD treatment (Morandi *et al.*, 1988; Han, 1996; Kantolic and Slafer, 2005; Jiang *et al.*, 2011). However, the photoperiod-sensitive cultivars resume vegetative growth with 'whole plant reversion' if the LD is over their critical photoperiod (Han *et al.*, 1998b; Jiang *et al.*,2011).

Soya beans are planted in a wide range of latitudes across the world, resulting from the rich diversity of variation in flowering and maturity time, whereas strict photoperiod sensitivity limits individual soya bean cultivars in a special latitudinal boundary (Cober and Morrison, 2010; Wong *et al.*, 2013). Large diversity in latitude preference results from variations in flowering genes and quantitative trait loci (QTLs) (Watanabe *et al.*, 2012; Wong *et al.*, 2013).

The extended photoperiod of high latitudes is suitable for soya bean cultivars that are less sensitive or insensitive to photoperiod because they flower and mature relatively early under such conditions (Upadhyay *et al.*, 1994). Vice versa, soya bean cultivars with different maturity groups (MGs) may have different photoperiodic responses and thus adapt to different day length conditions or latitudes.

Temperature response in soya bean

Soya bean is a thermophilic crop of which growth and development are affected by temperature (Gaynor *et al.*, 2011). The ambient temperature of soil greatly

affects emergence of soya bean (Pan *et al.*, 1982, 1985). After emergence, soya bean development is accelerated with increasing temperature (between 16 and 27°C).

The optimum temperature range at the flowering stage of soya bean is 25 to 28°C (Van Schaik and Probst, 1958), but lower temperatures delayed flowering (Roberts and Struckmeyer, 1939). The night temperatures are more effective than the accompanying day temperatures in determining the nature of the response (Hamner and Bonner, 1938). Thus far, controlling the night temperature has been proven to be consistently effective in changing the influence of photoperiod (Roberts and Struckmeyer, 1939).

A result showed that increases in the temperature (ranging between 15,6 and 32,2°C) caused an increase in plant height and number of nodes (Van Schaik and Probst, 1958). In addition, pod numbers per plant were the greatest at 34°C/26°C (day/night), rather than at 30°C/22°C (day/night), followed by day/night of 38°C/30°C (Allen *et al.*, 2018).

In addition to the growth period and agronomic traits, soya bean quality is also affected by temperature. Low temperatures cause a significant reduction of oil content (Howell and Cartter, 1953, 1958). Song *et al.* (2016) found that the crude oil content of soya beans had a quadratic regression correlation with the mean daily temperature (MDT). In addition, a positive relationship between crude oil content and MDT was discovered when the daily temperature was < 19,7°C.

The content of crude protein was negatively correlated with diurnal temperature range (DTR) but was positively correlated with an accumulated temperature ≥ 15°C (AT15) and MDT. However, the major bioactive components of soya bean, such as total isoflavones, phospholipids, and total oligosaccharides, were negatively correlated with AT15 and MDT, but positively correlated with DTR (Song *et al.*, 2018).

Unlike photoperiod responses, the thermal response is still not well understood in plants, especially in soya bean. In Arabidopsis, genomic responses to photoperiod and temperature are different during flower induction (Balasubramanian *et al.*, 2006). In addition, high temperatures change the structure of DNA, RNA, and protein (Vu *et al.*, 2019). Meanwhile, chromatin remodelling is regulated by temperature (Wigge, 2013). However, similar phenomena are not reported in soya bean.

Effect of photothermal interaction

Photoperiod and temperature are two important ecological factors that affect soya bean growth, development, and adaptation (Cai *et al.*, 2020). An interaction between photoperiod and temperature takes place, with greater effect of photoperiod on thermal sensitivity under SD conditions than under LD conditions, and with greater effect of temperature on photoperiodic sensitivity under high temperature than low temperature conditions (Cober *et al.*, 2001; Wu *et al.*, 2015). SD and warm temperatures promote flowering, whereas LD and cool temperatures delay flowering (Han, 1996; Rahman *et al.*, 2006; Kantolic and Slafer, 2007).

High temperatures coupled with LD conditions are not conducive to the reproductive development of soya beans (Wu, 2000; Cober *et al.*, 2001). Based on the effect of photoperiod and temperature on soya beans, a model of photoperiod-temperature interaction is proposed (Han 2007). According to this model, photoperiod dominates the direction of development, meaning that SD promotes but LD inhibits the developmental process.

On the other hand, temperature determines the development rate, i.e. high temperature promotes flowering under SD conditions and suppresses flowering under LD conditions above the critical photoperiod. Mao *et al.* (2017) confirmed the interactive effect of photoperiod and temperature on soya bean flowering at the molecular level, which was consistent with the theory of the mentioned photoperiod-temperature interaction model.

Breeding strategy

Nearly 3 000 soya bean cultivars have been officially released in China up to 2019. However, only around 5% of them were widely grown in farmers' fields (Wang *et al.*, 2015). Understanding the evolution of the widely grown cultivars will help improve soya bean adaptability.

The demand for soya bean is increasing rapidly with the growth of the population. Therefore, the expansion of soya bean cultivation regions worldwide is imminent. The photothermal characteristics of soya bean are crucial factors in determining the expansion of the planting region.

Up to now, many genes related to photothermal characteristics have been discovered in model plants and breakthroughs have also been made in the flowering pathway of soya bean. These approaches pave the way for improving the adaptability of soya bean to diverse photothermal environments.

Based on the thorough 'ecotyping' of the major widely-adapted soya bean cultivars as platforms, we can integrate molecular technologies with conventional breeding methods to breed superior and adaptable soya bean cultivars, thereby expanding the planting area of soya beans in order to meet the increasing demands for soya bean globally.

This is a shortened version of the published review. For the full review, visit Elsevier ScienceDirect at *www.sciencedirect.com*.

Precision plant breeding and genetic biofortification

By Claudi Nortjé

Several distinguished speakers contributed to the 13th Southern African Plant Breeding Symposium hosted by the Southern African Plant Breeders' Association (SAPBA) at the University of Pretoria's Future Africa Campus earlier this year.

The event looked at how the Fourth Industrial Revolution is driving digital transformation throughout the agricultural industry, changing the way agriculturalists live and work within the multidisciplinary nature of plant breeding.

Precision breeding

Richard Fly, head of breeding at Bayer South Africa, discussed precision breeding for the modern farm. "We are going to have an extra 2,2 billion people on earth by 2050, which means we need 50% more food than we currently consume. There is a massive amount of pressure on our ecosystems and resources, which means we have to start thinking differently about how we do things."

He says the science of plant breeding has improved by leaps and bounds over the last 100 years. "If you look at the area it took to cultivate ten bushels of maize in 1940 compared to what we are cultivating now, we have really made impressive advances. However, we need to focus on doing the small things really well and setting new standards in terms of sustainability to make sure we pioneer digital transformation and improve our overall productivity."

According to Richard, enhanced precision translates into better resource allocation, which will improve any breeding programme. "By considering which type of traits or alleles are interacting best in a particular climate and environment, we can gain insight into which type of alleles would be best suited to each country. This will enable us to leverage our global germplasm library effectively."

Genetic biofortification in Africa

Prof Maryke Labuschagne of the University of the Free State discussed genetic biofortification of crops in Africa. According to her, approximately 792,5 million people across the world are malnourished, of which 780 million live in developing countries. In addition, around two billion people suffer from hidden hunger caused by inadequate daily intake of essential micronutrients. One of the possible solutions to this global concern is genetic biofortification of crops.

"Biofortification is the process during which the nutrient density of food crops is increased through conventional plant breeding, improved agronomic practices, biotechnology or a combination of all of these factors, without sacrificing plant characteristics preferred by farmers and consumers," she explains.

Fighting hidden hunger

The biofortification approach involves fixed one-time costs in developing breeding methodologies, breeding nutritional quality traits into current crop varieties, and adapting these varieties to diverse environments. This approach will require minimum recurrent investments and the benefits can be made available globally, especially to all developing countries. Most importantly, breeding for higher trace mineral density in the consumed plant parts will not incur a yield penalty.

"Biofortification through conventional breeding offers a cost-effective, long-term and sustainable approach for fighting hidden hunger. About 300 biofortified crop varieties have been released for commercial production, with most of these produced through conventional breeding. At this stage, the crops have mostly been biofortified with minerals such as zinc and iron, or provitamin A.

"The agronomic approach focuses on optimising the application of mineral fertiliser and improving the solubilisation and mobilisation of the mineral elements in the soil. This is the simplest method among all the biofortification methods, but the success rate is highly irregular due to differences in mineral mobility, mineral accumulation among crops, soil composition and the location of each crop."

According to Prof Labuschagne, biofortification through conventional breeding is the most accepted method of biofortification. Nevertheless, there must be sufficient variation in the traits of interest for it to be feasible.

Conventional breeding limitations

Since the uptake and accumulation of micronutrients are controlled by polygenes and are dependent on genetic diversity for their traits, the conventional breeding-based biofortification approaches have not always been successful in all crops.

Transgenic approaches are an alternative to conventional breeding. "Transgenic technologies improve the genotypes by changing focused metabolic pathways. These technologies pave the way for modified proteins, vitamins, carbohydrates, minerals and other metabolites," says Prof Labuschagne.

"Ample research has been done on transgenics, but relatively few cultivars have been released so far. In contrast, research on conventional breeding has been limited with a higher number of cultivars available. When looking at the biofortification approaches of agronomics, transgenics and conventional breeding, you can see that cereals have benefitted the most, followed by legumes, vegetables, fruit and oilseeds."

Addressing concerns

The biggest problem is consumer acceptability, seeing as modified crops may differ physically from normal varieties. Marketing therefore plays an important role prior to commercial release. Regulatory processes are also very expensive and time consuming, especially in an African context. Many countries do not yet have supporting legislation in place, causing delays.

For more information or references, contact the author at claudi@plaasmedia.co.za.

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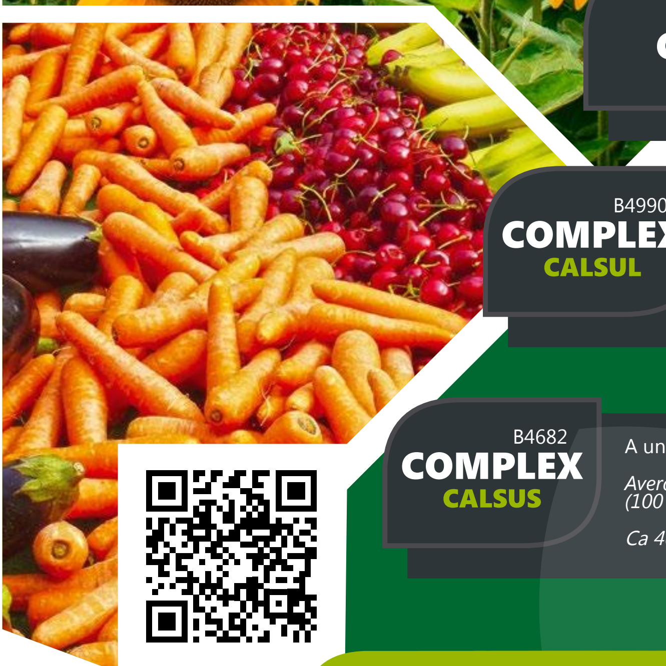

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Long-term benefits of certified seed in soya bean production

By Dr Antony Jarvie, Podsquad (Pty) Ltd

The seed that you use is the first of many farming inputs required to produce a successful soya bean crop. Failing at this first point in the production line, may compromise the value of all further inputs. It is thus vital that the starting point of your production is good quality seed of the best variety for your area.

Planting certified seed means that, at the very least, the minimum requirements for germination, vigour and genetic purity are met. Seed quality is a critical contributor to final yield, and consistently starting your crop off with certified seed is a sure way to improve yield and reduce risk over the long term.

Germination of seed

The first and most obvious contributor to good seed quality is high germination. It is possible to adjust the planting rate to accommodate the germination of a seedlot, but it is not the same as planting seed with high germination.

As we work towards precision farming, it becomes obvious that erratic plant stand has a negative effect on yield potential. The variability in the gaps between plants produced by non-emergent seed causes some plants to compensate for the extra space, leading to an increase in interplant competition. The net effect of elevated interplant competition caused by irregular germination is lower yield.

Importance of vigour

Low vigour is primarily a silent drag on yield, as reduced vigour is not always that apparent unless different seedlots are planted side by side. Vigour is a far more sensitive measure of seed quality than germination and it is more likely that the variability in the performance of different seed batches is ascribed to differences in vigour rather than germination.

As discussed, it is possible to partially mitigate the effects of suboptimum germination by increasing the planting rate, but the effects of low vigour are embedded in the initial growth rate. Low vigour seed will magnify the effects of any early stress, such as cold conditions during emergence or the ability to tolerate herbicide applications.

Genetic purity

Certified seed needs to meet certain genetic purity measures. It is firstly a guarantee that the variety chosen is in fact the variety planted. The genetic purity of this chosen variety is also important because of the potential impact that even a small amount of mixing can have on the harvest process. Where varieties of different maturity groups are mixed, delayed harvesting and reduced grain quality are frequently the result. One of the most visible indicators of the level of farm-saved seed in an area, is the tell-tale signs of variable senescence as the crop nears maturity.

Most farmers would choose to plant a range of soya bean varieties as a method of risk mitigation. This allows for some optimisation of cultivars based on planting date and soil type. The latest plant breeding innovations are accessible only through the purchase of certified seed.

Considering that the genetic gain in soya bean development in a company such as Corteva Agriscience™ is in the order of 1 to 2% per year, it makes sense to relentlessly pursue the purchase of new cultivars over a protracted period in order to make a tangible difference to the profitability of soya bean on your farm. This, in addition to the risk benefits of tested germination and vigour, can make soya bean production a load-bearing partner in your long-term crop rotation strategy.

Photograph by the United Soybean Board.

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The science of seed treatment **on soya beans**

By Jaco van Zyl, Bayer Crop Science

Seed treatment has been around for many decades and is becoming an important part of integrated pest management. The main objective of seed treatment is to increase the yield potential of a carefully chosen seed (adapted to specific growing areas) and to protect it against certain seed- and soil-borne insects and diseases.

Seed treatment is not only essential for successful crop establishment, but also acts as a 'vehicle' to apply other key components such as *Rhizobium* (inoculants) for nitrogen fixation in the case of soya beans. It is therefore a convenient application method, as you can load the required products on the seed to be available from the start of the plant's life; it is thus target specific in terms of area of application where protection is required.

However, seed treatment is in many respects a much wider field than simply putting product on the seed. A holistic approach is taken when treating seed and it normally comprises products, equipment, stewardship and the individuals who treat the seed. The treatment process therefore requires professional attention in terms of successful planning and implementation.

As soya bean seeds are vulnerable to splitting during handling, equipment specifically designed to limit the splitting of the seed must be used.

Efficacy of seed treatments

Soya bean is a growing crop in South Africa, and it is therefore important to understand and learn about the value of seed treatment as a key component in the production process. Soya bean seed can be particularly tricky to treat, firstly due to the physical characteristics of the seed surface, and secondly due to the integrity of the seed structure.

Soya bean seed can be damaged quite easily, especially when incorrect seed treatment processes are followed or when using seed treatment equipment not suited to the task.

Physical characteristics

Soya bean seeds have a smooth surface that complicates the drying process as well as adhesion of the seed treatment. In order to ensure maximum efficacy of the products being used, the correct equipment, calibration and recipe of products added together is key. The seed treatment mixture should first be registered and tested before use, to ensure a favourable return on investment and limited relevant risks (including compatibility).

Without accurate loading of the products on the seed, poor efficacy can be expected, leaving the seed less protected and open to resistance risks against the products applied. Products such as fungicides (assuming the correct loading is fully available) can significantly improve the plant population and stimulate vigour due to the overall healthier seedling at germination.

Soya bean seeds are vulnerable to splitting during handling and require equipment designed to limit splitting.

Application of biologicals

Applying biological- and chemical-based products together can be challenging, as their physical characteristics vary quite significantly. This compatibility challenge therefore requires separate applications in the same treatment process and can be achieved when mixing these products together, if the mixture can be kept in suspension by means of agitation.

Applying biologicals such as *Rhizobium* are particularly challenging, as the organism does not survive on the seed for very long (normally limited to 30 days). Pre-season treatment is therefore limited, in many cases forcing the industry to treat seed non-professionally, literally just before planting. Soya bean seed is therefore typically sold without an inoculation and only treated with a fungicide.

Stewardship risks emerge when re-treating seed, which can cause a loss of the initial treatment. In such a case 'in-furrow' application of the *Rhizobium* should rather be considered to avoid losses and be considerate of the environment, the safety of the operators and the sustainability of the molecules available.

The role of people

People play an integral role in successful seed treatment as precise skills and methods are required. In a professional seed treatment environment, operators undergo regular training on general personal safety, safe use of the products, as well as how to master the equipment that is used to ensure a properly cleaned and treated seed.

It is important to have seed professionally treated where possible, to get the most out of your investment and have peace of mind.

Equipment for seed treatment

Preventing soya bean seed from splitting requires special treatment equipment that is compatible with the conditions under which the seed will be treated, specifically focusing on ease of use and calibration. Well-designed equipment ensures even distribution of the products over and between seeds, giving individual seeds equal chance of survival.

Seed treatment equipment can easily be underestimated, especially when assuming that all seed treatment equipment delivers the same result. This is untrue as the equipment has a remarkable influence on the quality of the seed treatment and ultimately the quality and performance of the seed.

To professionally treat seed, equipment with software and hardware that is easy to operate and designed to apply the products correctly through its high technology pumps, is used. These machines sometimes have multiple pumps in order to apply products separately, but consecutively, on the seed, enabling us to avoid the mixing of products before application. This promotes the stability of the products being applied, handling of the products and ultimately stewardship.

The level of technology available for the treating of seed is excellent and helps industry utilise technology towards applying seed treatments more accurately and cost effectively.

Using quality seed

In the production of a crop such as soya bean, quality seed plays a vital role in producing a successful and profitable crop. A well-formulated seed treatment applied successfully and accurately, complements quality seed and helps ensure excellent plant stand as well as early growth, thus contributing significantly towards higher yield.

To achieve successful seed treatment the following should be considered:

- Pure, clean quality seed.
- Crop safe, well formulated and registered seed treatment products.
- Trained operators.
- Correct application method, recipe and equipment.

Stewardship responsibility

Role-players in the industry take stewardship very seriously. In all aspects of crop production it is important to protect and consider the environment for sustainable production of quality food. In the seed treatment environment, everything possible is done to ensure that the part we play in crop production is contributing towards a safe environment.

The soya bean industry is enabling a lot of investment and innovation by players such as Bayer in the form of new product registrations, as well as equipment to apply products professionally. Furthermore, vast amounts of data are being collected, as research fuels innovation and pipeline solutions. Soya bean is an exciting crop for South African producers. Watch the space.

For more information, email the author at jaco.vanzyl@bayer.com or visit *www.cropscience.bayer.co.za.*

Oil incentives:
Thinking differently about sunflowers

By Andries Wessels, portfolio manager: field crop seeds, Syngenta

The late Steve Jobs once stated that "Simplicity is the ultimate sophistication". In an oil industry that does not reward oil content, the simplistic value of sunflowers' oil content is overlooked. The value chain does not incentivise farmers for oil yield, which is perhaps the biggest disadvantage to the development of a crop in an industry that seems to be more focused on yield development.

Factors limiting yield

Research by stalwarts such as Dr André Nel suggests unequivocally that gains in sunflower yield lags far behind that of maize when measured over the same period. A few limitations relating to sunflower contribute to this harsh reality. Maize has a less complex genome when compared to sunflower and could be classified as a much more simplistic crop to breed.

Add to this the fact that genetically modified breeding technology is not available for sunflowers, and it becomes obvious that yield will be limited. Sunflowers are also not grown under irrigation and are often relegated to marginal soils for commercial production.

Combining these factors really does not bode well for sunflower farmers either, as the cost squeeze of rising input costs require them to have access to improved hybrids with superior yields that puts them ahead of the squeeze. The reality is that the gain in yield for sunflower is only 1% per annum; a dismal number compared to maize that has over 4% gain in yield year-on-year.

Sunflower does, however, have some industry advantages when compared to maize. When looking at Crop Estimates Committee numbers, there is some stability in sunflower plantings, indicating that the crop has value in marginal areas and is especially well-suited to areas where late plantings are the norm. Many farmers can testify to the value of harvesting sunflower early, as it relieves pressure on cash flow and workloads can be spread during the harvesting period.

The value of incentives

When comparing the local oil industry to that of our international peers, our value chain lacks a reward system for oil content. In the United States, European Union and Argentinean markets, farmers are rewarded for oil content on top of their commodity prices. This begs the question: As oil is such a valuable plant-based commodity, why is the same route not followed in South Africa?

Several arguments could be tabled, ranging from a price sensitive consumer base, crushing capacity that is fairly concentrated in ownership, and genetics that do not lend themselves to oil content as they were the casualties of a system that does not reward oil content. Whatever the argument, the essence is that everyone involved in the value chain – from farmers to crushers to consumers – is at a disadvantage when there are no incentives for oil.

Perhaps the Argentinean model gives some much needed clarity. It allows for farmers to be rewarded a 2% price premium for every one percentage point above 40% oil content on an 'as is' basis. For example, a farmer delivering sunflower with a 44% oil content will receive a price premium of 8%.

This oil content increase also has significant downstream advantages for crushers who simply procure based on volume needs and who do not benefit from higher grain yields directly. By simply increasing the oil content in a ton of sunflower that is fed into a crushing facility, no additional expenses have to be incurred to extract the oil, which benefits output.

Local drive to boost oil content

Local efforts to drive the value capture of oil incentives have been actioned by the Oilseeds Advisory Committee (OAC). The project entails the OAC's commissioning of the Bureau for Food and Agricultural Policy to study the viability of oil incentives in the industry, as well as the factors that influence oil yield at farm level.

The Agricultural Research Council's annual sunflower trial report also gives some interesting insights into the difference between hybrids when comparing oil. From these reports it is evident that significant value can easily be unlocked by simply selecting hybrids based on their oil yields, and not getting stuck in the groove of grain yield as primary selection criteria for hybrid selection.

The 2019 report shows that SY 3970 CL has a whopping 51% oil concentration average across sites. This underlines the value of hybrid selection for oil concentration in a bid to easily unlock the largest gains in value capturing in the oil industry, as opposed to improvements in grain yields.

The reset button on the value of oil concentration needs to be pressed for the whole industry to benefit. If farmers benefit from improved oil yield hybrids that are already available, the industry can be transformed, and the simplicity of an oil trait will initiate true market sophistication.

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Biochemical warfare:
Soya bean vs yellow nutsedge weed

By Prof Charlie Reinhardt

Despite its modest size and relatively sparse above-ground biomass, yellow nutsedge (*Cyperus esculentus*) is rated among the world's top ten crop-damaging weeds. It is an annual plant (it completes its life cycle in one calendar year), but production of tubers on underground stems (rhizomes) effectively extends its life with a year, when tubers formed in a particular year sprout the following year.

Yellow nutsedge spreads mainly through tubers and not nearly as effectively by sexually produced seeds – the seeds are viable, but seedlings lack vigour for survival in field situations.

In South Africa's summer rainfall region, it tends to be the first weed species to emerge in spring, which often necessitates control measures even before the crop is established. Its establishment early in the growing season greatly augments the competition ability of this weed, thus making effective, early-season control essential.

Yellow nutsedge plant with tubers on rhizomes. Each tuber can sprout later in the same season in which it was produced, or remain dormant until the following growing season.

Impact on crop yields

Rhizomes of yellow nutsedge are concentrated in the upper 15cm soil zone, resulting in 80% and more of the tubers occurring in this zone. Tubers form on rhizomes four to six weeks after seedling emergence. Due to the shallow rhizome and root systems of this weed, germinating crop seed and seedlings are in close proximity and even in direct contact with live or dead parts of the weed, especially in heavily infested soil.

Yellow nutsedge's impact on the yield of various crops due to competition for growth factors (water, light and nutrient elements) is well documented. For example, cotton yields decreased with an increase in yellow nutsedge densities – average yield loss of 19kg/ha for each additional tuber occurring in 1m crop row length, and 18kg/ha lost for each additional nutsedge plant per square meter.

Beware, it is not only competition from live yellow nutsedge plants that pose a threat to crops; plant litter of the weed, which is present in or on the surface of soil, can also inhibit crop growth. This is not due to competition for light, nutrients or water, but due to the release of phyto (plant) toxic chemicals called 'allelochemicals' from the weed's litter.

Research showed that tuber residues incorporated in growth medium reduced the growth of soya bean seedlings more than it did maize seedlings. Soya bean growth was also significantly reduced by the addition of water extracts prepared from tubers to the growth medium. Growth inhibition of both crops was greatest when the tuber residues in the growth medium were in direct contact with the crop seeds. It was postulated that growth-inhibiting chemicals (allelochemicals) present in the tubers of yellow nutsedge inhibited the growth of maize and soya bean in particular.

The concept of allelopathy

Several phenolic compounds that commonly occur in plants and are known for having allelopathic (phytotoxic) effects have been identified in tubers of yellow nutsedge. Compounds identified included p-coumaric, ferulic, p-hydroxybenzoic, syringic, vanillic, salicylic, protocatechuic and caffeic acids, with p-coumaric and ferulic acids occurring in the highest concentrations.

High concentrations of the natural plant hormone, abscisic acid (ABA), were found in tubers that were in a state of dormancy. The highest ABA concentration attained in dormant tubers was 6,81 microgram per gram tuber material. ABA concentration gradually dissipated as spring approached until, upon sprouting of tubers, ABA was no longer present, or present in an undetectable low concentration.

Despite its name, ABA does not directly initiate abscission (leaf drop, fruit drop) in plants, although in the 1960s, when it was named, botanists thought that it did. The principal effect of ABA is inhibition of cell growth. ABA concentration gradually increases in developing seeds, until it induces seed dormancy when it has reached optimal concentration. If leaves experience water stress, ABA amounts increase rapidly, causing the stomata to close. In this way, ABA protects plants that experience water stress (drought) conditions. ABA also prepares plants to be ready for winter by slowing plant growth and causing buds to become dormant.

Production of the natural plant hormone ethylene has long been linked to herbicidal effects of hormone-, or auxin-type, herbicides such as 2,4-D and MCPA. It is ethylene that causes the typical 'epinastic' (malformation of leaves and stems) growth responses in plants that are susceptible to the auxin-type herbicides. Recently it has been revealed that an increase in ABA production is actually the primary plant response to those herbicides, and ethylene production the secondary response. Ethylene at phytotoxic concentrations causes early senescence of plants due to breakdown of plant cell constituents and tissue collapse, and plant death can follow within days.

Ethylene, which is a gaseous molecule, finds commercial application in the form of synthetic ethylene used for ripening of unripe fruit under controlled conditions. Under natural conditions, ethylene can be released in the form of a gas into the environment. It is therefore plausible that ABA, ethylene, and possibly other phytotoxic allelochemicals can be exuded from yellow nutsedge tubers, and perhaps also from other underground plant parts, to have phytotoxic (allelopathic) effects on crops that are infested by the weed.

Although the discussion here is limited to yellow nutsedge, various studies have reported similar effects (allelopathy and competition) on crops for its close relative, purple nutsedge (*Cyperus rotundus*). In terms of notoriety the latter shares the weed status of yellow nutsedge. Globally and locally both species are severely harmful weeds. Locally, yellow nutsedge apparently prefers dry land conditions, whereas purple nutsedge tends to thrive under irrigation. Both are formidable opponents of the farmer seeking to destroy them.

Soya bean fights back

Can soya bean defend itself against yellow nutsedge and other weeds?

Even with drastic intervention, the yellow nutsedge residues (alive or dead) left in the soil, can exert crop-damaging allelopathic effects on a crop such as these tomatoes.

Soya beans have one distinct advantage over nutsedge weeds; it can rapidly develop a dense canopy that makes it highly competitive for the one growth factor that yellow nutsedge needs a lot of – sunlight.

Research showed that crops maintaining dense canopies for an appreciable part of the growth season, which created a regime of low light intensity during a long yellow nutsedge growth period, suppressed tuber formation more strongly than crops that shadow the weed for a relatively short period of time.

A crop such as maize, planted in 75cm rows, did not provide enough shade to prevent yellow nutsedge from producing tubers. Less light reaching the plant means lower photosynthesis, which results in lowered production of energy-rich carbohydrates used in plant growth and reproduction. Tubers, as storage organs, are particularly strong 'sinks' for carbohydrates produced by photosynthesis in leaves, the 'source'.

Glyphosate-tolerant crops such as soya beans have made weed control easier, especially in zero-tillage systems, and fortunately, glyphosate-resistant yellow and purple nutsedge have not been reported anywhere in the world, yet. The best practice herbicide programme for nutsedge control would include an array of herbicide modes of action that can be applied pre-plant, pre-emergence and post-emergence.

Do soya beans possess allelochemicals that can suppress weeds? A survey of literature revealed at least one study conducted by researchers at Purdue University on soya bean allelopathy. Field and greenhouse experiments showed significant retardation of wheat germination and seedling emergence when wheat seed was sown into soya bean residues shallowly incorporated into soil after harvest. This would suggest that soya bean litter exudes allelochemicals; if the growth of wheat could be inhibited, why can the same process not be followed with weeds?

The allelopathic characteristic has already been proven for several crop species, and is exploited in practice for weed suppression (e.g. use of intercropping, cover crops and organic mulches), and even in the quest to develop novel herbicides from biochemical leads or precursors, i.e. allelochemicals, present in plants.

Hopefully more research will be forthcoming, as it makes sense and improves economics if the crop can assist with controlling weeds by biochemical means, thereby relieving pressure on the use of synthetic chemicals such as herbicides.

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Chemical control of Sclerotinia diseases: A fungicide-resistance approach

By Lisa Rothmann and Marlese Meiring

Fungicides, the agrochemicals controlling fungal pathogens, have been contributing relief to crop management systems for centuries, protecting yields and assisting in providing uncompromised quality. Over time, many new chemistries with novel structures and systemic activity have been developed, providing a more potent effect in terms of disease control.

The application methods and optimised timing of fungicides have evolved alongside these technologies, in combination with an integrated pest management strategy, using complimentary non-chemical interventions to minimise the effects of crop diseases. While hundreds of fungicidal compounds exist, few target crop-pathogen specific needs effectively and reliably (Brent and Hollomon, 2007).

Registered active ingredients

In South Africa, there are limited registered active ingredients to manage diseases caused by *Sclerotinia sclerotiorum*.

Benomyl is registered as a sunflower seed treatment. The remaining active ingredients listed are recommended for application at early bloom – ~1 to 20% flowering depending on the crop. Procymidone is registered for application on dry bean, green bean, soya bean and pea. The management of *Sclerotinia* stem rot of canola is possible with either azoxystrobin or a combination of prothioconazole and tebuconazole, while leafy vegetables, such as lettuce, can be controlled with a combination of cyprodinil and fludioxonil (AVCASA, 2018).

Registered products are applied at different application frequencies in fields due to the nature of disease variation between provinces, as a result of pathogen virulence and inoculum potential, host susceptibility and environmental conduciveness.

Pathogen sensitivity

Fungi that are successfully controlled by fungicides are known as 'sensitive' to the active ingredient, thus the pathogen will be negatively affected and the crop protected. In contrast, pathogens that are not affected by the fungicide are known to be 'insensitive' or 'naturally resistant'; in such instances the product will not provide sufficient protection to the host.

When an active ingredient or product with a similar mode of action (MoA) or mixture is used for prolonged periods, the pathogens may no longer be effectively controlled by a once adequate product (Brent and Hollomon, 2007). In this instance, the pathogen 'acquires resistance' through the emergence, selection and adjustment of pathogen genetics to the pressure imposed on them to survive (Brent and Hollomon, 2007; van den Bosch *et al.*, 2011).

Managing pathogen resistance

Field resistance of plant disease fungal pathogens is known to develop against fungicides, threatening the effectiveness and future use of products (FRAC, 2019). *S. sclerotiorum* has varying sensitivity to fungicide application in the field.

In Brazil, procymidone is used extensively to control *Sclerotinia* rot of the common bean. Brazilian isolates of *S. sclerotiorum* indicated low to rare levels of resistance; however, resistance management practices were suggested to reduce the likelihood of the spread of fungicide resistant genotypes of the pathogen (Lehner *et al.*, 2015).

The control of canola stem rot in China is managed with the application of dimethachlon (a dicarboximide, the same fungicide group as procymidone). Chinese isolates collected and evaluated indicated resistance or insensitivity to the fungicide applications in the laboratory and in field trials. This dilemma has left the Chinese to find alternate MoAs to control canola stem rot, as the effectiveness of the dimethachlon is threatened by the resistance observed (Ma *et al.*, 2009).

Local considerations

Looking at these two examples, it is critical that fungicide resistance to local pathogens, local environments and local crop genotypes be considered. In Brazil, fungicide resistance to procymidone was rare in contrast to observations in China, where an active ingredient from the same fungicide group indicated fungicide resistance and did not provide sufficient control.

The Fungicide Resistance Action Committee (FRAC) was established in 1994 to address issues surrounding resistance management and provide countermeasures to reduce or delay resistance. Fungicide resistance is a complex and devastating occurrence – likely inevitable in modern agricultural practices – and should be considered by all crop management specialists when developing a disease control system (Brent and Hollomon, 2007).

References available on request.
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Producing oilcake safe for use in animal feed

By Johan Schieke, associate product manager, Kemin Industries

Oilseed oils are usually produced using one of two different processing methods: mechanical screw pressing, or a combination of chemical extrusion and physical expelling (screw pressing).

During processing the oilseeds are subjected to very high temperatures, which reduces the bacterial risk in the oilcake to virtually zero. Unfortunately, this can all be undone if the oilcake becomes recontaminated further down the production process. Oilseed by-products remain one of the raw materials with the highest risk for bacterial contamination, according to test results, with Salmonella contamination a particular risk.

High risk of contamination

The cooling process is one of the production steps that poses the highest risk for recontamination. Coolers are the fulcrum point where heat is dissipated, creating a location where both moisture and some residual heat from steam and evaporation accumulate (especially where coolers run continuously). This creates an ideal environment for bacterial growth as moisture, heat and nutrients are required for bacterial growth, all of which are supplied in these types of production areas.

As oilcake continuously moves through the cooler, it can be recontaminated by contact with any bacteria present on the surfaces of the cooler. Equipment surfaces further down the production process can also be a possible risk for bacterial recontamination.

Managing storage options

Storage of oilseed by-products is another critical focal point, as it is central to the production of safe ingredients used in animal feed and human food. The facilities at which by-products are stored, should be clean (and regularly cleaned and maintained through a hygiene programme) and the environment should be kept dry and well ventilated. Equipment used to transport and move the by-products, must also be kept clean and dry through a regular cleaning programme.

If the by-products are stored in bags, they need to be bagged at a temperature higher than 5°C above the ambient temperature, to prevent condensation inside the bags. The bags should also preferably be porous, to allow for continued ventilation during storage. Any excess moisture can cause mould and bacterial growth over time.

This will reduce the quality of the products by reducing its nutritional value (as microbes, such as bacteria and moulds, consume nutrients in order to grow) and contaminating it with potentially harmful bacteria, which may cause possible detrimental health problems in the livestock and people consuming these products.

Possible preventative measures

In the cooler and production areas, the following actions can be considered:

- Thorough physical cleaning of the inside of the cooler/production areas and removal of old product. This should be done as often as possible, preferably daily and at least weekly. Physical cleaning of the surfaces is essential, to remove dust that can be a carrier of bacteria, such as Salmonella.
- The application of an antimicrobial product onto the production surfaces can be considered to reduce microbial levels and thus reduce the risk of recontamination in these high-risk areas. These surfaces should always first be physically cleaned as far as possible before the antimicrobial is applied, for it to be effective at disinfecting the target surface. The use of an antimicrobial should be repeated daily, to prevent recontamination and control microbial growth rates. The antimicrobial should also ideally be able to reach and treat some of the areas that cannot be physically cleaned.

During storage and transportation, the following actions can be considered:

- The floor of the warehouse where the by-products will be stored should be kept clean and dry through a regular cleaning programme. The use of an antimicrobial product is advised to disinfect the floor and any contact surfaces, and ensure that bacterial loads are kept as low as possible, especially if the by-products will be in direct contact with the area/floor.
- If the by-products are stored in bags, the bags should be kept clean, dry and cool. The bags should also allow for ventilation, with correct spacing and stacking, to prevent the build-up of excess moisture/condensation and potential heat from microbial growth.
- Any machinery being used to transport or move the by-products need to be physically cleaned and disinfected with an antimicrobial as often as possible (at least weekly, preferably daily after each shift).
- The trucks or other vehicles delivering the products should also be kept clean and be disinfected between deliveries. Special attention should be given to the inside of the vehicles into which the product is loaded, to ensure that disinfection takes place before every new load is transported.

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A shock like no other:
Coronavirus rattles commodity markets

As countries around the world contend with the health emergency of the COVID-19 pandemic, the economic effects of suspending almost all activity have immediately impacted the world's commodity markets and are likely to continue to affect them for months to come.

The pandemic has affected both the demand for and supply of commodities, the April edition of the *Commodity Markets Outlook* reports. Those effects are direct, resulting from shutdowns to mitigate the spread of the virus and disruptions to supply chains, and also indirect, as the global response slows growth and leads to what is anticipated to be the deepest global recession in decades.

The full impact of the pandemic on commodity markets will depend on how severe it is, how long it lasts, and how countries and the world community choose to respond to it. The pandemic has the potential to lead to permanent changes in the demand and supply of commodities, and especially to the supply chains that move those commodities from producers to consumers around the world.

Oil market and energy prices

The effects have already been dramatic, particularly for commodities related to transportation. Oil prices have plunged since January, and prices reached a historic low in April with some benchmarks trading at negative levels. Declines reflect a sharp drop in demand and have been exacerbated by uncertainty around production levels among major oil producers.

Due to mitigation efforts that have limited most travel, oil demand is expected to fall by an unprecedented 9,3 million barrels per day this year from the 2019 level of 100 million barrels per day. Oil prices are expected to average $35 per barrel in 2020, a sharp downward revision from the October forecast and a 43% drop from the 2019 average of $61 per barrel. Prices for natural rubber and platinum, both heavily used by the transportation industry, have also tumbled.

Figure 1: Drop in commodity prices as coronavirus pandemic worsened. (Source: World Bank)

Recent efforts by the Organization of the Petroleum Exporting Countries (OPEC) and other oil producers to cut production in response to the plunge in demand, will ease some of the pressure on oil markets. However, over the longer run, the current arrangement, to the extent that it supports prices, will be subjected to the same forces – the emergence of new producers, as well as substitution and efficiency gains – that led to the collapse of previous OPEC arrangements and other commodity pacts.

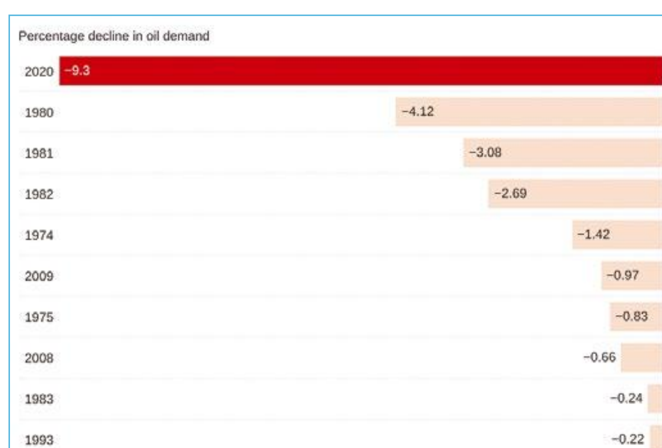
A section of the report looks at OPEC in the context of the history of previous co-ordinated efforts to manage the prices of certain commodities.

Energy prices overall, which also include natural gas and coal, are expected to be 40% lower in 2020 than in 2019, although a sizeable rebound is anticipated next year. Natural gas prices have fallen substantially this year, but coal prices have been less affected since the demand for electricity has been less affected by mitigation measures.

Industrial commodities

The halt in economic activity has taken a toll on industrial commodities such as copper and zinc, and metal

Figure 2: Drop in oil demand outpacing previous global recessions. (Source: BP Statistical Review, IEA and World Bank)



prices overall are expected to fall this year. A deceleration of economic growth in China, which accounts for half of the global metal demand, will weigh on industrial metal prices. Gold prices, on the other hand, have risen as buyers have sought safety amid financial market turbulence.

Agriculture and food markets

Agriculture prices are less tied to economic growth and have undergone only minor declines over the first months of the year, with the exception of rubber that fell sharply, and of rice that rose due to worsening crop conditions and some trade restrictions. Overall, global agricultural prices are expected to remain broadly stable in 2020 as production levels and stock of most staple foods are at record highs.

Most food markets are well supplied. However, concerns about food security have escalated as countries announce trade restrictions, which include export bans on certain commodities, and engage in excess buying. Similarly, agricultural commodity production, especially next season, could be affected by disruptions to the trade and distribution of inputs such as fertiliser, pesticides and labour. Snags to supply chains have already affected the exports of perishable products, such as flowers, fruit and vegetables, from some emerging market and developing economies.

Despite well supplied markets, export restrictions could hurt food security in importing countries. The World Bank has joined other organisations in calling for collective action to keep food trade flowing between countries.

Economic impact of COVID-19

The impact of the COVID-19 pandemic on commodity markets may result in longer-term changes. Transport costs may be higher due to additional border-crossing requirements. Higher trade costs in particular will affect agriculture and food commodities and textiles. Decisions to stockpile certain commodities could affect trade flows and have an effect on global prices.

Commodity-dependent emerging markets and developing economies will be among the most vulnerable to the economic impacts of the pandemic. In addition to the health and human toll they face, and the effects of the global economic downturn, reduced demand for exports and disruption of supply chains will take a toll on the economies of these countries.

Article courtesy of *www.worldbank.org.*

Photograph by Marco Verch, www.flickr.com.

The impact of COVID-19 on soya bean markets

By Ikageng Maluleke, Grain SA

The COVID-19 pandemic has plunged the world into a global health crisis. Most countries are under lockdown, while some are slowly easing regulations and getting back to normal. However, it is no secret that the pandemic is changing market dynamics, bringing with it a lot of uncertainty.

It is still not known what COVID-19's impact will be in the long term. In the short term, however, the main concern is the impact of lockdowns and trade barriers on grains and oilseeds. For instance, earlier in the year Argentinian grain trucks were blocked and soya beans could not reach crushing plants or international markets. Argentinian exports only picked up again in late March.

Lockdowns are making it difficult for trade to occur seamlessly. If countries increase logistical restrictions and protectionism, short-term food shortages will become a reality. In the long term expectations are that global economic recessions will have a negative effect on the value of food commodities.

Global production

Looking at global soya bean production for 2019/20, it is expected that production will drop by around 7% compared to the 2018/19 season, owing to a downgrade in prospects for South America. Soya bean yields in some parts of Brazil and Argentina came out lower than expected following extended periods of hot and dry weather during critical stages of development.

Global consumption

In light of the COVID-19 pandemic, the animal feed sector is facing major challenges; countries such as Romania have banned grain and oilseed exports to non-European countries, creating supply problems. India has also further disrupted the animal feed supply chain with the partial closure of its international ports.

The soya bean crush pace picked up substantially in February and March in the United States (US), which remains a hot spot for soya bean use as exports continue to disappoint. However, an expansion in crushing activity in the US may be hampered by the decline in demand from the animal feed sector, locally and internationally.

There has been a decrease in the consumption of fish and meat globally, therefore reducing demand for grains and oilseeds. It is estimated that the demand for soya bean for animal feed will decrease by 6% in countries such as Vietnam, Thailand, Malaysia and the Philippines this year. The animal feed sector is

Table 1: Global supply and demand of soya beans. (Source: USDA, May 2020)

	2018/19	2019/20	
	Estimate (million tons)	2 April (million tons)	7 May (million tons)
Production	366,1	342,7	339,3
Supply	415,5	401,1	399,7
Consumption	353,6	359,5	356,5
Trade	150,3	151,6	152,7
Ending Stocks	60,4	42,9	46,5

Table 2: Local soya bean supply and demand. (Source: Grain SA, NAMC, 2020)

	2019/20	2020/21
Production (CEC)	1 170 345	1 290 750
Opening stocks (1 March)	502 241	138 455
Total supply	1 646 518	1 648 805
Total demand	1 508 063	1 449 650
Ending stocks	138 455	119 583

responsible for almost 65% of total global consumption of soya bean, while 35% is meant for human consumption. Although human consumption has increased, it is still greatly outweighed by the reduced consumption in animal feed.

The closure of restaurants and associated businesses has led to a dip in demand for vegetable oil in the past few months, which weakened soya bean oil prices. The different restrictions in place that limit the movement of people and goods have led to a decrease in demand for fuels used for transportation, which resulted in the erosion of crude oil value. Consequently, industrial demand for soya bean oil for biodiesel production will likely be negatively impacted.

International trade

There is a lot of uncertainty regarding soya bean trade globally, mainly due to the impact of COVID-19 on demand, especially for the animal feed sector. The trade forecast for 2019/20 shows a 1,3% increase in trade globally compared to the previous season, with an increase in imports expected from China. With the Brazilian currency weak and a bumper harvest of soya bean, there has been strong demand from China – in April, China imported 34,5 million tons of soya bean from Brazil.

Many expected that the increase in demand for Brazilian soya bean would threaten US farmers' hopes of booming exports from the US-China trade deal. Yet despite ongoing tensions between the US and China regarding the COVID-19 pandemic, both countries fully expect to meet their obligations under the Phase One agreement signed in January this year.

Global stocks and prices

Global ending stocks for 2020 are expected to be the lowest in five years. This is despite prospective stock replenishments in China. Instead, it is a reflection of tight stocks in the US and other major producing countries.

Due to the uncertainty created by COVID-19, global soya bean prices continue to be under pressure. Although China has increased its imports from the US, a lower Brazilian real is putting pressure on US soya bean prices.

Local soya bean market

In consideration of the impact of the COVID-19 pandemic, the South Africa government imposed a nationwide lockdown on 27 March this year; the lockdown was scaled down from 1 May. All production and commercial activities within the food supply chain were declared as essential and thus continued to be exempt from lockdown regulations, including trade and mobility of the workforce employed in the sector.

In terms of soya bean, the concerns raised by the lockdown relate mainly to the slowdown of trade and bottlenecks in the supply chain of machinery and equipment for harvesting, as well as other production inputs. Although South Africa's production of soya bean has increased over the years, there is still a considerable amount imported in the form of oil and oilcake.

According to the Crop Estimates Committee (CEC), soya bean production is projected at 1,2 million tons for the 2020/21 season (*Table 2*), with opening stocks of approximately 138 455 tons (1 March 2020). On average South Africa's demand for soya bean is around 1,4 million tons, with around 85% used for crush and the rest used for human consumption and full-fat animal feed.

In view of the change in market dynamics, there is still a lot of uncertainty in the markets. We could see a decrease in soya bean oil demand owing to the closure of many restaurants and other related businesses. We could also experience a decrease in demand for animal feed mainly due to the African swine fever (ASF) outbreak in the Eastern Cape, together with the anticipated decrease in demand from consumers due to COVID-19.

Throughout the 2019/20 season, local soya bean prices have decreased due to pressure from international markets and high global stock levels. Soya bean prices for April this year increased by 43% compared to April 2019, while July futures prices increased by approximately 45% compared to the previous year. The price support is mainly due to the depreciation in the rand over the past few months caused by COVID-19 and other market factors.

In conclusion

It is not possible to predict the myriad ways COVID-19 could affect South Africa's agricultural food supply chains. However, the country has substantial advantages in terms of natural endowments to produce and process soya beans and to supply a big portion of the local market.

Government's commitment towards food security by assisting the agricultural sector to weed out any bottlenecks in the supply chain, will instil confidence in respect of consistent supply during these uncertain times.

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Soya bean crop quality survey results: 2018/19 production season

By Jolanda Nortjé, manager: laboratory, Southern African Grain Laboratory NPC

The first and very crucial step in any crop survey is obtaining the samples that will provide information about the quality of the crop. Without the co-operation of the commercial grain silo owners, members of Agbiz Grain who supply these samples to the Southern African Grain Laboratory NPC (SAGL) at no cost, these surveys would not have been possible.

Each delivery of soya beans at the various delivery points throughout the soya bean production regions, is sampled as per the grading regulations for grading purposes. After grading, the graded samples are placed in separate containers according to class and grade, per silo bin/bag/bunker at each delivery point. Once 80% of the expected harvest has been received, the content of each container is divided with a multi-slot divider to obtain a 3kg sample.

If there is more than one container per class and grade per bin/bag/bunker, the combined contents of the containers are mixed thoroughly before dividing it with a multi-slot divider to obtain the required 3kg sample. The samples are marked clearly with the name of the depot, the bin/bag/bunker number(s) represented by each individual sample, as well as the class and grade and then forwarded to the SAGL.

The samples received at the SAGL are selected to proportionally resemble the Crop Estimates Committee's production estimate figures per province, as closely as possible.

Table 1: Comparison between the moisture, crude protein and crude fat results of the crop quality and ARC cultivar trial samples of the 2018/19 season.

Analysis	Moisture % (17hr, 103°C)	Crude protein % (as is)	Crude fat % (as is)	Crude protein % (db)	Crude fat % (db)
Soya bean crop quality survey results					
Average	7	37,60	17,8	40,43	19,1
Minimum	6	33,13	15,3	35,43	16,5
Maximum	11,4	41,84	20,4	45,09	22,0
Standard deviation	0,67	1,20	1,16	1,30	1,24
Number of samples	150	150	150	150	150
ARC Grain Crops cultivar trial sample results					
Average	8	37,32	18,9	40,54	20,5
Minimum	7,3	33,08	16,1	36,01	17,4
Maximum	8,5	42,24	21,9	46,05	23,8
Standard deviation	0,29	1,40	1,23	1,55	1,34
Number of samples	180	180	180	180	180
% difference between crop and cultivar samples	-1,0	0,3	-1,1	-0,1	-1,4

Grading of samples

All 150 samples selected for the 2018/19 survey were graded according to the *Regulations relating to the grading, packing and marking of soya beans intended for sale in the Republic of South Africa (Government Notice No R 370 of 21 April 2017).* A total of 134 (89%) of the samples were graded as grade SB1 – during the previous two seasons this figure was 87 and 88%, respectively. The main reasons for downgrading the samples were the percentage other grain, the percentage soiled soya beans, as well as the number of *Datura* sp. and *Convolvulus* sp. seeds exceeding the maximum permissible percentage or number according to the regulations.

Other grains are defined as grains or pieces of grains of wheat, barley, oats, triticale, maize, rye and sorghum. Soiled soya beans means whole soya beans that do not pass through the 4,75mm screen and that are discoloured by soil or other substances (if the discolouration is caused by plant material, such soya beans shall not be regarded as soiled).

National weighted averages

The national weighted average percentage of soiled soya beans was 3,1%, compared to the 1,53% of the previous season. Six samples exceeded and one sample equalled the maximum permissible deviation of 10%. The highest percentage reported was 36%. All these samples originated in Mpumalanga. Last season, three samples exceeded this grading limit.

The percentage of samples containing sclerotia from the fungus *Sclerotinia sclerotiorum* decreased from 59% (88 samples) in the previous season to 27% (41 samples) this season. The five highest percentages sclerotia observed ranged from 0,44% (sample from Gauteng) to 0,24% (samples from Mpumalanga and the Free State). These percentages are, however, still well below the maximum permissible level. The national weighted average percentage

this season was 0,03% compared to the 0,06% of the previous season.

The national weighted average percentage of soya beans and parts of soya beans above the 1,8mm slotted sieve, which passed through the 4,75mm round hole sieve, decreased from 1,54% the previous season to 1,13% this season. The weighted average percentage defective soya beans on the 4,75mm sieve increased from 1,91% last season to 2,3% this season. Wet pods were not present in any of the samples.

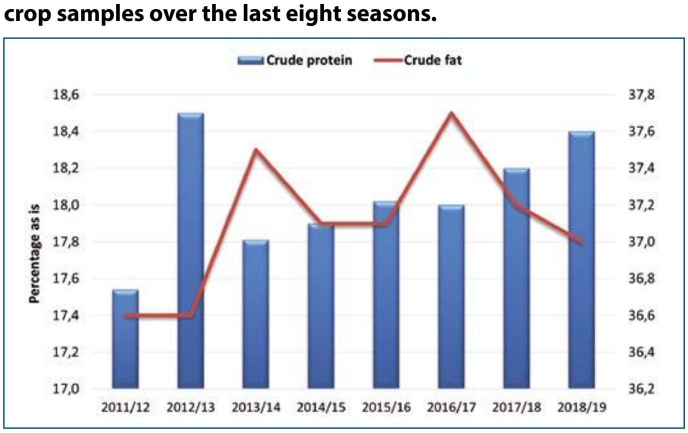
Notable results

The 2018/19 season is the first season in which the SAGL conducted moisture, crude protein and crude fat analyses on the soya bean cultivar trial samples of the ARC Grain Crops. *Table 1* contains a comparison of the results of the crop survey and cultivar trial samples.

The weighted average crude protein content of the crop samples this season was 37,6% compared to the 37,4% of the previous season. As in the previous two seasons, Limpopo had the highest weighted average crude protein content (38,74%); the Free State (36,9%) reported the lowest average. The weighted average crude fat percentage of 17,8% was slightly lower than the 18% in the previous season and also the lowest of the last six seasons.

The samples from KwaZulu-Natal had the highest weighted average crude fat content, namely 19,2%. The lowest average fat contents were observed in the Free State and Northern Cape with 17,3 and 17,4%, respectively.

Figure 1: Crude protein and crude fat results of the soya bean crop samples over the last eight seasons.



The weighted average percentage crude fibre varied from 5,8% in KwaZulu-Natal to 7% in the Northern Cape. The South African weighted average, 6,3%, was the second highest of the annual surveys since the 6,8% reported in the 2015/16 season. This season, the average ash content was 4,34%, the highest of the eight seasons since commencement of the crop surveys and 0,07% higher than the previous season.

Samples from the Northern Cape and Limpopo, as well as the North West to a lesser extent, tend to show higher ash contents over seasons compared to the other provinces. The nutritional component analyses results in this article are reported on an as is/as received basis.

Fatty acid profile analyses

An exciting and important addition to the quality survey this season is the inclusion of fatty acid profile analyses. Fatty acid profiles are the most important tool for identifying the authenticity of vegetable fats and oils. All types of oil have their own specific fatty acid profile that is unique to that product. The unique fatty acid profile of each product/crop is a combination of saturated, monounsaturated and polyunsaturated oils and is specific to that type of oil.

The fatty acid profiles of every crop, however, are subject to variation. The variation or typical pattern of fatty acids in a specific oil not only influences the stability and physical properties of the oil, but also aids in distinguishing one type of oil from another. The variation of fatty acids within the same product depends on climate, latitude, soil type, cultivar, rainfall as well as seasonal variation. These variations should be included when ranges for identifying authenticity are determined.

It is imperative to include ranges in which fatty acids vary in order to successfully validate the authenticity of a specific vegetable oil. Building a database requires gathering of information over different seasons, areas and cultivars in order to give a true reflection of the ranges wherein fatty acids can differ. There is currently no national updated database for the fatty acid composition of soya bean oil.

It is important that South Africa, as a soya bean producing country, develops and maintains a national fatty acid profile database to the benefit of the oilseeds industry. Annual analysis of crop and cultivar samples will ensure that the natural variation caused by different cultivars, as well as the influence of climate and locality, are included in the database values. Seasonal variations will also be addressed. Recording all variations applicable to the crops in the database will enable the annual review of the specified ranges.

Precision Oil Laboratories was subcontracted to perform fatty acid profile analyses on 20 composite crop samples representing different production regions, as well as 21 cultivar samples from different localities supplied by the ARC Grain Crops. A total of 20 different fatty acids were included in the profile analysis.

With gratitude to the Oil and Protein Seeds Development Trust for financial support of these annual surveys and to the members of Agbiz Grain for providing the crop samples.
For more information, contact the Southern African Grain Laboratory NPC on 012 807 4019 or visit *www.sagl.co.za*.

Sunflower crop quality survey results: 2018/19 production season

By Jolanda Nortjé, manager: laboratory, Southern African Grain Laboratory NPC

The absence of or an incomplete or outdated database when decisions need to be taken, can cause significant problems to the industry. This was the main reason for the Oil and Protein Seeds Development Trust's decision to fund the annual sunflower crop quality surveys eight years ago. It is, however, imperative to regularly review the scope of analysis included in these surveys to ensure that it meets the needs of the industry.

Precision Oil Laboratories, a laboratory that provides testing, training and consultation services to the oil industry, was consulted by a large seed-oil producer in South Africa to determine if an unexpected variation of one of the fatty acids in a sunflower seed batch was acceptable.

After extraction of the sunflower oil, it was rejected by a food processing company, indicating that one of the fatty acids was not within their specification. In the absence of an updated national database for the fatty acid composition of sunflower oil, the *Codex Alimentarius* was consulted, but it did not accommodate the range of the fatty acid in question.

After a literature search, the American database proved that wide ranges for the specific fatty acid were acceptable since certain factors, including drought, could lead to the fatty acid having increased acceptable ranges. The seed containing the fatty acid, which was out of range, was produced during a particularly dry season, explaining the wide range. If a national database were kept and maintained, the time and money lost by the industry as a result of rejected batches could have been avoided.

It is important that South Africa, as a sunflower seed producing country, develops and maintains a national fatty acid profile database to the benefit of the oilseeds industry. The inclusion of fatty acid profile analyses from the 2018/19 production season is an important addition to the annual crop quality surveys conducted by the Southern African Grain Laboratory NPC (SAGL).

Building a fatty acid profile database

Fatty acid profiles are the most important tool for identifying the authenticity of vegetable fats and oils. All types of oil have their own specific fatty acid profile, which is a combination of saturated, monounsaturated and polyunsaturated oils and unique to that product/crop. The fatty acid profiles of every crop, however, are subject to variation.

The variation or typical pattern of fatty acids in a specific oil not only influences the stability and physical properties of the oil, but also aids in distinguishing one type of oil from another. The variation of fatty acids within the same product depend on climate, latitude, soil type, cultivar, rainfall as well as seasonal variation. These variations should be included when ranges for authenticity identification are determined in order to successfully validate the authenticity of a specific vegetable oil.

Annual analysis of crop and cultivar samples will ensure that the natural variation caused by different cultivars, as well as the influence of climate and locality, are included and reflected in the database values. Seasonal variations will also be addressed. Recording all the variations applicable to the crops in the database, will enable the annual review of the specified ranges.

Precision Oil Laboratories was subcontracted to perform fatty acid profile analyses on 20 composite crop samples representing different production regions, as well as 20 cultivar samples from different localities supplied by the ARC Grain Crops. A total of 20 different fatty acids were included in the profile analysis.

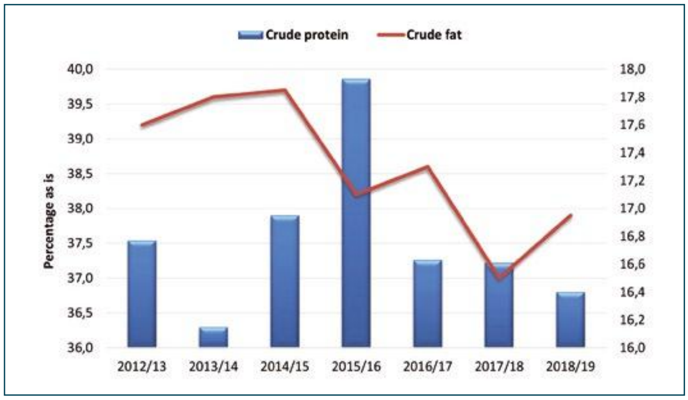
Sampling of crops

A total of 176 composite samples representing sunflower seed harvested and delivered to various delivery points throughout the sunflower production regions of South Africa during the second quarter of 2019, were selected to resemble the proportions per province according to the Crop Estimates Committee's production estimates as closely as possible.

A total of 133 (76%) of the samples were graded as Grade FH1 according to the *Regulations relating to the grading, packing and marking of sunflower seed intended for sale in the Republic of South Africa* (Government Notice No 45 of 22 January 2016). The percentage FH1 samples decreased compared to the 81% of the previous season. In the 2016/17 season, this percentage was 85%.

A total of 43 samples were downgraded to 'Class Other Sunflower Seed'. The main reason for downgrading the samples was

Figure 1: Crude protein and crude fat results of the sunflower crop samples over the last seven seasons.



as a result of the percentage of either the screenings or the collective deviations, or a combination of both, exceeding the maximum permissible deviations of 4 and 6%, respectively.

Gauteng (three samples) reported the highest weighted average percentage screenings, namely 4,13%, followed by the North West (N = 58) and Mpumalanga (N = 8), both with 2,62%. Limpopo (twelve samples) reported the lowest average percentage screenings, namely 1,47%. The weighted national average was 2,21% compared to the 1,91% of the previous season.

The highest weighted average percentage foreign matter (1,36%) was reported on the 95 samples from the Free State. North West followed closely with an average of 1,34%. The lowest percentages were found in Mpumalanga and Limpopo with 0,85 and 0,71%, respectively. The South African average was 1,28% compared to the 1,16 and 1,06% of the previous two seasons.

The number of samples received for this survey that contained sclerotia from the fungus *Sclerotinia sclerotiorum*, increased from 78 samples (44%) in the previous season to 90 samples (51%) this season. Sixty one of these samples originated in the Free State, 25 in the North West and two each in Mpumalanga and Gauteng.

Four of these samples (one from North West, two from the Free State and one from Mpumalanga) exceeded the maximum permissible deviation of 4%. Weighted average levels ranged from 0% in Limpopo to 0,98% in Mpumalanga; the Free State's weighted average was 0,49%. The national average of 0,43% is the second highest since the 0,53% of the 2013/14 season. Last season's average was 0,17%.

Nutritional content results

The weighted average crude protein content this season was 16.4% compared to 16,61% the previous season. Limpopo had the highest weighted average crude protein content at 18,3% and Mpumalanga the lowest with 15,41%. Mpumalanga has consistently reported the lowest average protein content since commencement of this survey in the 2012/13 season. The North West's crude protein content averaged 16,71% and that of the Free State 16,06%.

The weighted average crude fat percentage of 37,9% was almost one percent higher than last season's 37%, but still the second lowest of the last six seasons. Limpopo had the highest weighted average crude fat content at 39%, closely followed by Gauteng with 38,9%. The North West had the lowest average fat content at 37,6% and the province also reported the lowest average in the previous two seasons.

The weighted average percentage crude fibre was the highest of the last seven seasons at 22,4% (21,9% in 2017/18). Average values varied between 20,2% in Limpopo to 23% in the North West. The weighted average ash content was 2,6%, slightly lower than the 2,69% of the previous season. The provincial averages ranged from 2,37% in Mpumalanga to 2,64% in the Free State. The nutritional component analyses are reported as percentage (g/100g) on an as received or as is basis.

Table 1 contains a comparison of the moisture, crude protein and crude fat results between the crop survey and ARC Grain Crops sunflower cultivar trial samples.

Samples for the current (2019/20) production season are expected to be received by the SAGL from June/July 2020. The results will be available on the SAGL's website as soon as possible thereafter.

Table 1: Comparison between the moisture, crude protein and crude fat results of the crop quality and ARC cultivar trial samples of the 2018/19 production season.

Analysis	Moisture % (17hr, 103°C)	Crude protein % (as is)	Crude fat % (as is)
Sunflower crop quality survey results			
Average	4,7	16,40	37,9
Minimum	2,9	12,41	28,5
Maximum	7,7	20,02	45,2
Standard deviation	0,6	1,49	2,51
No of samples	176	176	176
ARC Grain Crops cultivar trial sample results			
Average	4,8	16,44	43,6
Minimum	3	10,10	34,4
Maximum	6	25,37	55,4
Standard deviation	0,63	3,65	4,49
No of samples	144	144	144
% difference between crop and cultivar trial samples	-0,1	0	-5,7

With gratitude to the Oil and Protein Seeds Development Trust for financial support of these annual surveys and to the members of Agbiz Grain for providing the crop samples.

For more information, contact the Southern African Grain Laboratory NPC on 012 807 4019 or *visit www.sagl.co.za*.

Oja! Farms: Pioneering soya bean products for human consumption

By Claudi Nortjé

Jannie and Martin Cloete are fourth generation farmers who farm Bonsmara cattle and maize in the heart of the Mpumalanga Highveld. In 2007, they introduced soya beans as a rotation crop on their farm Leeuwpoortjie, to benefit soil health. They opted to cut out the middleman by establishing their own processing plant in a bid to pioneer soya bean products fit for human consumption.

Their revolutionary approach to soya bean processing is a first in South Africa and allows them to provide a cheaper meat alternative without skimping on high protein content. Soya is also known as a rich source of various vitamins and minerals, making it ideal for staving off malnutrition on a global scale.

Worth their weight in gold

Soya bean production at Leeuwpoortjie is still relatively small, with only 100ha planted to soya in the last year. In the Mpumalanga region, the planting period of soya beans starts in October and can last until December, depending on rainfall. The harvesting period usually falls between April and June.

They have been applying no-till on their farm for more than ten years to decrease soil erosion and increase the overall health of the soil. After harvesting, the soya bean residues are left behind as roughage for their Bonsmaras. This way, the manure of the cattle can add much-needed organic matter and beneficial micro-organisms to the soil. Feed is scarcer in the winter months, which means that soya bean residues are worth their weight in gold when added to the animals' diet.

An ongoing learning process

"Compared to maize, the insurance costs of soya beans are almost double. We are also in the midst of a national sclerotinia outbreak, which is one of the most destructive soya bean diseases in South Africa. Currently, there are no chemicals available to control outbreaks and no cultivars that are disease resistant. It is by no means easy to farm soya bean plants in South Africa, and we have a long way to go to catch up with what the Argentinians and Brazilians are accomplishing."

Soya bean cultivars selected for regional use have been successfully tested and trialled over several years to determine how they respond to daylight length, temperature during growing and disease challenges. Cultivar selection is usually influenced when these parameters are added to potential yield. The continuous introduction of new technology and cultivars has had a positive effect on average yields.

"We experiment with different cultivars and keep those that produce high yields under various climatic conditions. Cultivars that do well here may not do so well in other parts of the country, so it is an ongoing learning process when it comes to increasing our yields.

"The primary reason we farm soya beans is because it is an excellent rotation crop when used in conjunction with maize. Soya beans allow farmers to use fertiliser containing less nitrogen when growing maize, which aids the growth of microbes in the soil. Ultimately, if you use maize and soya beans in rotation it benefits the environment and allows you to save on input costs," he adds.

Soya beans undergoing processing at Oja! Farms.

Processing of soya beans

After harvesting, the soya beans are stored and sifted before being roasted. Instead of extracting the oil and removing the outer parts, they use the entire bean. By not removing the outer layer, the soya beans retain their 36% protein and 18% oil content, of which 12% is polyunsaturated fat.

Jannie and Martin Cloete's soya bean processing facility on their farm in Mpumalanga.

Oja! Farms processes soya bean products for human consumption. Their revolutionary approach to soya bean processing is a first in South Africa.

Humans cannot eat soya beans in its raw form as it contains protease compounds that inhibit protein digestibility. However, thermal processing destroys these protease compounds, making soya beans safe to consume. While other processing units may opt to heat soya beans using a regular oven, Jannie finds that this method burns the outside of the beans before the inside has even started to cook.

To prevent this from happening, they roast their beans in a specially designed oven that utilises microwave technology to heat the beans to approximately 150°C. "This oven allows the soya beans to be cooked from the inside out. The roasted beans therefore have the same outward appearance as raw beans. This unique process results in a dry bean with a nutty taste."

The plants are normally harvested when their moisture content is 13%. However, the moisture level of the beans will drop slightly while being stored, which then influences the amount of time the beans need to be roasted to achieve moisture levels fit for packaging. The roasting process usually takes an hour.

Along with roasting soya beans, they also make soya nuts at their processing plant by soaking the beans in water after it has been sifted and then roasting it until the taste and texture resembles that of a peanut. They outsource most of the packaging, design and seasoning of their products.

Diversifying the product range

Soya beans in South Africa are mostly processed for animal feed and oil, seeing as it is more profitable. However, a small percentage of soya beans are also used for human consumption. Traditional soya products on the market, such as soya mince, have a characteristic flavour that consumers have become well acquainted with. These products are normally produced by using the dry by-products of the soya bean after the oil has been extracted. By using the whole bean, the taste of their soya products differs vastly from that of traditional soya products.

"The soya nuts are packaged in small packets to be consumed as an on-the-go snack and comes in an assortment of flavours. The dry, roasted soya beans can be used in stews and soups or can even be milled and used in smoothies, gravies or in your morning cereal," Jannie explains.

They have kept the modern consumer's needs in mind when it comes to taste, convenience and nutrition by introducing snack bars, and also offer boxed meal-kits, which allow for the integration of their dry, roasted soya beans into traditional South African dishes such as bobotie and biryani.

Spreading the word

Seeing as soya beans have not really been utilised in this manner on a commercial scale in South Africa before, customers are hesitant to try something new. In a bid to advertise and introduce people to Oja! Farms' products, Jannie says they do a lot of demonstrations on how to prepare their roasted soya beans while giving onlookers an opportunity to taste the finished product. They are also involved in several feeding schemes and have recently joined forces with the non-profit organisation, Solidariteit Helpende Hand.

Jannie explains that 100g dry, roasted beans can deliver 500ml soup, which equals two cups containing 18% protein – this adds up to just over R1 per cup without adding extras such as onions and vegetables. When compared to the protein content and price of other meat products available, you will not find a cheaper source of protein.

"This is a source of protein we should utilise to not only benefit farmers, but also for the sake of food security. Where farmers are usually paid around R6 000/ton for soya beans, they could theoretically earn R12 000/ton by cutting out the middleman.

"I think that to remain profitable, future farmers will have to start processing their own crops or settle for farming a lot more hectares per year. However, by processing their own crops, they will have the opportunity to buy other farmers' produce and continue making their own products if their own harvest underperforms due to drought or pests," he concludes.

For more information, phone Jannie Cloete on 079 142 9198 or visit *www.ojafarms.co.za.*

Health benefits of soya bean consumption

By Prof Anna Arnoldi, School of Pharmacy, University of Milan

Soya bean has a high protein content and is rich in lipids, in particular polyunsaturated fatty acids, a-linolenic acid included. It also contains vitamins, minerals and phospholipids such as lecithin, which facilitate the metabolism of cholesterol.

Being almost devoid of starch and purines, it is particularly suitable for diabetics. The cholesterol-reducing effect of soya proteins became the basis for the US Food and Drug Administration's (FDA) approval of the health claim for the role of soya protein consumption in coronary disease risk. In addition, ancillary benefits of soya, i.e. blood pressure reduction and possibly reduced body weight, are of considerable therapeutic interest.

Introduction

Soya bean (*glycine max*) is a herbaceous plant belonging to the family of *Leguminosae*. It is native of Eastern Asia and cultivated for food purposes. The leaves of the plant vary in colour between green and yellow. The flowers are small and in clusters and the fruits are pods about 50cm long with seeds used to produce oil and flour.

In respect of other legumes, soya bean is more digestible and richer in protein, as well as associated with fewer problems of flatulence. It has a high protein content (about 35-40%) and is rich in lipids (15-20%), in particular polyunsaturated fatty acids, a-linolenic acid included. It also contains vitamins (A, B, B2, D and E), minerals (calcium, iron and potassium) and phospholipids such as lecithin, which have emulsifying properties and facilitate the metabolism of cholesterol.

Being almost devoid of starch and purines (metabolised in the body to uric acid), it is particularly suitable for diabetics.

Anti-cholesterol activity

In many countries soya foods are appreciated for their potential role in atherosclerosis prevention. In fact, soya protein has been shown to successfully reduce cholesterolemia in experimental animals, as well as in humans with cholesterol elevations of genetic or non-genetic origin.

In the earliest studies in the 1970s, a soya protein preparation, given to hospitalised highly hypercholesterolemic patients, was found to be highly effective for cholesterol lowering and well tolerated. In this six-week controlled crossover investigation, there was a 20 to 22% reduction in total cholesterol (TC) level and a 22 to 25% reduction in LDL-C, without significant changes of triglyceridemia. The cholesterol reduction was inversely related to baseline cholesterolemia and not modified by the addition of dietary cholesterol.

The numerous ensuing clinical studies were summarised in a meta-analysis of 38 studies up to 1995, in both hypercholesterolemic and normolipidemic individuals. This meta-analysis confirmed that serum LDL-C concentrations are modified, depending on the baseline cholesterolemia, from a minimum of -7,7% in subjects with total cholesterol in the normal range (<200mg/dl), up to -24% in subjects with a clear-cut hyper cholesterolemia.

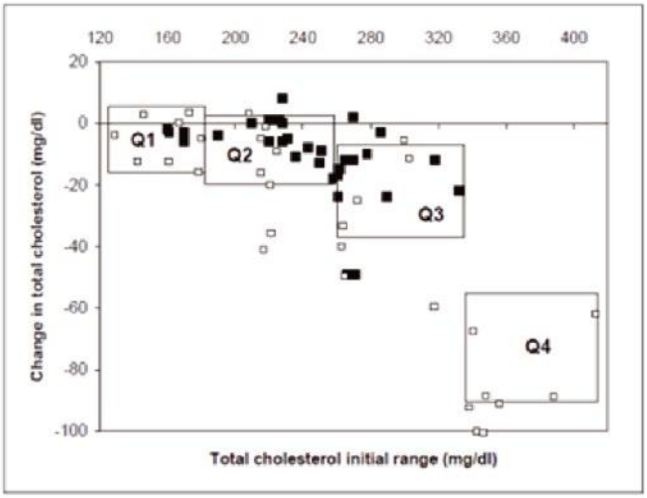
The cholesterol-reducing effect of soya proteins, potentially leading to a reduced cardiovascular risk, became the basis for the FDA's approval of the health claim for the role of soya protein consumption in coronary disease risk reduction.

Photograph courtesy of www.kjokkenutstyr.net.

Role of hyperlipidemics

A meta-analysis published in 2006 criticised these results, since the studies published in the following years apparently did not confirm the powerful cholesterol-reducing effect of soya proteins. This apparent incongruence may be explained by the fact that clear-cut hyperlipidemics are always excluded in recent trials for ethical reasons, since

Figure 1: Initial cholesterol values and net cholesterol changes after soy protein based diets in the studies evaluated in the meta-analysis by Anderson *et al*. and in later studies.



Boxes indicate the Anderson normogram, i.e. the initial ranges of cholesterol values and 95% confidence intervals of cholesterol changes for each quartile considered in the Anderson meta-analysis (Reproduced from Future Lipidology 2007, 2, 313-339 with permission of Future Medicine Ltd).

today to treat these subjects with hypolipidemic drugs is compulsory.

Figure 1 compares the cholesterol reductions observed in the studies included in the Anderson meta-analysis (white points) and more recent investigations (black points) versus the average baseline cholesterol level of each study. This chart demonstrates very clearly that both in old and recent studies, the ranges of cholesterol responses of the groups of patients belonging to the same quartiles of baseline cholesterol, are essentially identical.

It confirms also that about 25% of old studies were based on severely hypercholesterolemic individuals, whereas in recent years patients with cholesterolemia in the very high range (>335mg/dl) have never been selected for dietary treatment.

The efficacy of soya protein in cardiovascular prevention has been confirmed by the 20-year follow-up of the *Nurses Health Study*, which indicated a significant correlation between vegetable protein intake and reduced cardiovascular risk.

Hypocholesterolemic effects of soya

Rodent and in vitro studies have attempted to establish a link between the hypocholesterolemic effects of soya and the activation/depression of liver low-density lipoprotein receptors (LDL-R). Animals on cholesterol/cholic acid dietary regimens with casein have a dramatic down-regulation of liver LDL-R and this effect is reversed in the presence of soya proteins.

Two studies have addressed the potential of soya protein preparations to increase LDL-R expression in human beings. In the former FH patients were treated with animal protein or textured soya protein (with the addition of cholesterol to balance the two diets). Both plasma lipids and LDL degradation by circulating lymphomonocytes (used as mirror images of hepatocytes) were monitored.

After the animal protein diet there were minimal changes in LDL-C levels or LDL-R activity, whereas during the soya protein diet, in addition to a marked LDL-C reduction, an increase of around eight-fold in LDL degradation was observed. This study, clearly suggesting that some soya protein components are able to up-regulate LDL-R mediated LDL degradation, was subsequently confirmed in individuals with lesser cholesterol elevations.

Reduced cholesterolemia

Studies on the mechanism whereby soya proteins may reduce cholesterolemia have clearly indicated that the intact soy protein per se is effective for cholesterol reduction, not a mixture of soy amino acids. The identification of soya bean components responsible for the hypocholesterolemic effect has received a significant contribution from the early clinical studies where soya protein products contained less than 0,15mg/g isoflavones versus contents of 2 to 3mg/g very frequently encountered in most commercial soya bean products.

While initially the responsibility of these phytoestrogens in cholesterol reduction was suggested primarily on the base of studies in monkeys, a number of more recent reports have definitely concluded that dietary isoflavones make no contribution to the hypocholesterolemic action, including a clinical study performed on pure genistein.

A full understanding of the mechanism of action of soya protein has become vital for the selection of the most appropriate forms of soya for treating hypercholesterolemia. This selection can only be made once the active component/s and their mechanism of action have been fully elucidated. Proteomics may be a powerful tool to achieve this objective.

The major storage proteins of soya beans are 7S and 11S globulins. From early studies the 7S globulin appeared to be primarily responsible for the hypocholesterolemic effects of soya protein preparations, whereas the 11S component appeared essentially inactive. Very recently a hypocholesterolemic protein sub-component has been pinpointed more precisely, i.e. by showing that the isolated 7S globulin a' subunit given to cholesterol-fed rats leads to a strong up-regulation of liver LDL-R activity as well as to dramatic plasma cholesterol/TG reductions.

Hypotensive activity

Biologically active peptides or functional peptides are food derived peptides that also exert a physiological effect in the body. They are inactive in the original protein but, once released, function as regulatory compounds with hormone-like activity. They may be released from the parent protein during gastrointestinal digestion or during food processing.

Active peptides in general contain from two to 20 amino acid residues and are partially or totally resistant to hydrolysis. They may be absorbable and thus exert systemic effect. Activities may be very different, including angiotensin I converting enzyme (ACE) inhibition, anti-thrombotic and anti-microbial activities.

Original article published in the International Legume Society's journal, *Legume Perspectives, Issue 1, January 2013*.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Modification of egg yolk fatty acids profile by using different oil sources

By Mohsen Omidi, Shaban Rahimi and Mohammad Ali Karimi Torshizi, Faculty of Agriculture, Tarbiat Modares University, Tehran

Oils and fats are usually added to the diet of poultry to enhance the energy density to produce energy-rich formulations. In order to ensure adequate levels of linoleic acid and to improve palatability and reduce the dustiness of diets, all poultry diets require a minimum of 1% added fat, regardless of other economic or nutritional considerations.

It was shown that there was a different constitution in terms of the structure of fatty acids (FAs). Fatty acids contain carbon, oxygen and hydrogen, and are classified as saturated FAs or SFAs, monounsaturated FAs or MUFAs, or polyunsaturated FAs or PUFAs.

Animal fat contains palmitic acid as a long-chain (LC) SFA, except for fish oil; vegetable oils contain high quantities of long-chain unsaturated FAs. Several studies have shown better utilisation of unsaturated fats with a higher metabolisable energy compared with saturated fats. Rat and broiler studies have shown that unsaturated vegetable oils produce lower faecal energy losses and, consequently, higher ME than animal fats.

In addition, laying hen studies have shown that unsaturated vegetable oils have higher energy levels than saturated animal fats. Oil supplements are added to layer hen rations to increase the absorption of fat-soluble vitamins and to enhance egg yield and weight.

In recent years, consumer demands for more healthy food supported the interest in modifying the FA profile of eggs. Omega-3 FAs are essential for normal growth and development and play important roles in the prevention and treatment of coronary heart disease (CRD), hypertension, inflammatory autoimmune disorders and cancer. However, since the consumption of fish – the richest dietary source of LC n-3 PUFA in diets – is low, intakes of LC n-3 PUFA are low and suboptimal.

Researchers agree that the optimal ratio of omega-6 to omega-3 should not exceed 2:1 to 4:1. The dietary imbalance in FAs (excessive omega-6 and insufficient omega-3) is an underlying cause of many chronic diseases, including cardiovascular disease, cancer, inflammatory diseases, autoimmune diseases and many physiological disturbances.

Fish oil contains unsaturated FAs with long omega-3 chains (LC-n-3 PUFA), eicosapentaenoic acid (EPA20:5n-3) and docosahexaenoic acid (DHA22:6n-3) that improve health-related factors in humans and animals. High intakes of long-chain n-3 PUFAs are associated with a decreased risk of cardiovascular disease. Many studies are directed towards the manipulation of the FA composition of broiler chicks and laying hens in order to increase the n-3 PUFA content and decrease the n-6/n-3 ratio in poultry meat and eggs. It is possible to modify the FA profile of the yolk by changing the lipid sources of the hen diet. Nutritional manipulation of hen diets to include sources of PUFA n-3 promotes deposition of these nutrients in egg yolk.

The objective of this study was to compare the effects of different oil sources on performance and the FA composition of egg yolk in laying hens.

Animals and experimental design

For the study, 72 23-week-old laying hens (Tetra-SL) were divided randomly into six dietary treatments (four replicates and three birds per replication). Each three-bird group was housed in one cage (40 x 40 x 50cm). Environmental temperature was set at 22°C.

A regime of 14 hours of constant lighting (15 lux) and continuous ventilation were provided. All the birds were kept under uniform management conditions throughout the experimental period. Experimental diets included:

- Control (no oil).
- 3% fish oil.
- 3% olive oil.
- 3% grapeseed oil.
- 3% canola oil.
- 3% soya bean oil.

Diets were formulated according to the recommendations of the National Research Council. Feed and water were provided *ad libitum* throughout the experiment. Diets were modulated as isoenergetic and isonitrogenous. At the end of the trial (ninth week), seven eggs were randomly selected from each group to determine the FA profile of the egg yolk.

Performance record

Egg production, egg weight, feed intake, egg mass and feed conversion ratio of each pen were recorded weekly.

Fatty acid content

The FA composition of the dietary oil and yolk samples was determined by gas chromatography according to the method described by Metcalfe *et al.* The FA content was determined using a gas chromatograph (Model 4600, Unicam, Cambridge, England) equipped with a BPX70 fused silica capillary column and a flame ionisation detector (Unicam, Cambridge, England). The column head pressure of the carrier gas (helium) was 20psi and the sample volume injected was 0,2µL. Pentadecanoic acid (Sigma-Aldrich, St. Louis, Unite States) was used as internal standard. The FAs were identified by matching their retention times with those of their corresponding standards.

Statistical analyses

Data was analysed in a completely randomised design using SAS software (Version 8.0, SAS Institute, Cary, United States). Significant differences among treatments were determined according to the general linear model (GLM) procedure. Means were compared by using Duncan's multiple-range test and significance was determined when the p-value was less than 0,05.

The following model was used: $X_{ij} = \mu + \tau_j + \varepsilon_{ij}$ where X_{ij} is the observation of jth treatment and ith pen; μ is the overall means of the sampled observation; τ_j is the effect of treatment; and ε_{ij} is the experimental error component.

Table 1: Fatty acid composition (%) of oils included in the diets of laying hens.

Fatty acids[1]	Fish oil	Olive oil	Grapeseed oil	Canola oil	Soya bean oil
C14	5,61	0,10	0	0,08	0,34
C16:0	27,43	14,18	7,28	6,21	15,57
C16:1	7,97	0,89	0,07	0,17	0
C18:0	4,44	4,41	3,99	2,67	3,97
C18:1	32,84	68,88	20,62	57,86	23,50
C18:2	1,59	10,59	67,80	27,45	55,53
C18:3	0,23	0,84	0,24	5,56	1,10
C20:4	0,09	0,09	0	0	0
EPA	5,59	0	0	0	0
DHA	14,2	0	0	0	0
SFA	37,48	18,70	11,27	8,97	19,88
MUFA	40,81	69,77	20,69	58,02	23,5
PUFA	21,71	11,53	68,04	33,01	56,62
n-3	20,02	0,84	0,24	5,56	1,1
n-6	1,69	10,69	67,8	27,45	55,53
n-6/n-3	0,08	12,69	283,11	4,94	50,67

1 C14:0 = Myristic acid; C16:0 = Palmitic acid; C16:1 = Palmitoleic acid; C18:0 = Stearic acid; C18:1 = Oleic acid; C18:2 = Linoleic acid; C18:3 = Linolenic acid; C20:4 = Arachidonic acid; EPA = Eicosapentaenoic acid; DHA = Docosahexaenoic acid; SFA = Saturated fatty acid; MUFA = Monounsaturated fatty acid; PUFA = Polyunsaturated fatty acid; n6/n3 = Ratio of n-6 to n-3 PUFA.

Composition of different oils

The FA composition of the fish, olive, grapeseed, canola and soya bean oil is shown in *Table 1*. The fish oil was a rich source of LC PUFA, n-3 and contained EPA (5,59 %) and DHA (14,20%). The fish oil had the highest amount of C14:0, C16:0, C18:0, EPA, DHA, SFA and total omega-3 FAs and the lowest amount of C18:2. Olive and canola oil were rich in C18:1 and had 69 and 58% of this FA, respectively. The grapeseed and soya bean oil were rich in C18:2 and had 68 and 55,5% of this FA, respectively.

Performance

The effects of different sources of oil on laying hen performance are summarised in *Table 2*. At the end of the experiment, the hens' egg production, feed intake, feed conversion ratio, egg weight and egg mass changes were not significantly affected by treatments ($p > 0,05$).

Table 2: Performance of laying hens in response to experimental diets.

Experimental diets	Egg production (%)	Feed intake (g/day)	Feed conversion ratio	Egg mass (g/day)	Egg weight (g)
Control	98,06	119,61	2,06	58,07	59,21
Fish oil	98,51	117,41	2,03	57,83	58,7
Olive oil	98,51	118,31	2,06	57,36	58,22
Grapeseed oil	96,87	117,13	2,1	55,83	57,66
Canola oil	99,26	121,19	2,1	57,63	58,06
Soya bean oil	98,36	117,99	2,02	58,4	59,36
P value	0,295	0,955	0,813	0,568	0,736
SEM	0,249	0,970	0,016	0,345	0,736

Table 3: Fatty acid composition (%) of the egg yolk of laying hens fed different sources of oil.

Fatty acids[1]	Control	Fish oil	Olive oil	Grape seed oil	Canola oil	Soya bean oil	Significance	SEM
C14	0,45^{c}	0,51^{b}	0,58^{a}	0,45^{bc}	0,39^{d}	0,43^{cd}	*	0,016
C16:0	29,25	29,47	29,32	30,20	27,05	26,74	NS	0,372
C16:1	4,47^{a}	4,19^{a}	3,42^{b}	3,13^{bc}	3,16^{bc}	2,90^{c}	*	0,131
C18:0	7,86^{bc}	6,95^{d}	7,63^{c}	8,16^{b}	7,58^{c}	8,95^{a}	*	0,134
C18:1	45,66^{a}	45,86^{a}	47,00^{a}	37,06^{c}	46,99^{a}	41,27^{b}	*	0,837
C18:2	10,21^{d}	8,76^{e}	9,79^{d}	18,72^{a}	12,29^{c}	17,32^{b}	*	0,898
C18:3	0,17^{e}	0,28^{d}	0,37^{c}	0,10^{f}	0,81^{a}	0,55^{b}	*	0,052
C20:4	1,74^{ab}	0,59^{c}	1,52^{b}	1,97^{a}	1,74^{ab}	1,83^{a}	*	0,099
EPA	0,00^{b}	0,18^{a}	0,00^{b}	0,00^{b}	0,00^{b}	0,00^{b}	*	0,014
DHA	0,19^{c}	3,21^{a}	0,37^{b}	0,20^{c}	0,00^{d}	0,00^{d}	*	0,243
SFA	37,56	36,93	37,53	38,82	35,01	36,13	NS	0,342
MUFA	50,13^{a}	50,04^{a}	50,42^{a}	40,19^{c}	50,15^{a}	44,17^{b}	*	0,905
PUFA	12,31^{d}	13,02^{d}	12,05^{d}	20,99^{a}	14,83^{c}	19,70^{b}	*	0,841
n-3	0,36^{e}	3,66^{a}	0,74^{c}	0,30^{e}	0,81^{b}	0,55^{d}	*	0,246
n-6	11,95^{d}	9,35^{e}	11,31^{d}	20,69^{a}	14,03^{c}	19,15^{b}	*	0,965
n-6/n-3	33,52^{b}	2,55^{d}	15,33^{c}	68,61^{a}	17,45^{c}	34,94^{b}	*	4,398

*a-f Different superscripts indicate significant differences ($p < 0,05$); NS = Not significant; SEM = Standard error of the mean; * = $p < 0,01$.*
1 EPA = Eicosapentaenoic acid; DHA = Docosahexaenoic acid; SFA = Saturated fatty acid; MUFA = Monounsaturated fatty acid; PUFA = Polyunsaturated fatty acid; n6/n3 = Ratio of n-6 to n-3 PUFA.

Egg yolk fatty acid composition

The effects of different feed sources on the composition of egg yolk FAs is shown in *Table 3*. The FA profile of the egg yolk was significantly affected by the treatments (except C:16 and SFA). As shown in *Table 3*, the values of EPA, DHA and total omega-3 FAs were significantly higher ($p < 0,01$) in the egg yolk of laying hens fed fish oil compared to the eggs of other treatments.

Fish oil reduced C18:0, C18:2 (14% less than control group), C20:4 (66% less than control group), total omega-6 FAs and the n-6/n-3 ratio in egg yolk compared to other groups. Egg yolk C18:2 and total omega-6 FAs from birds fed grapeseed oil were significantly higher than those of the other five oils.

Furthermore, canola oil supplementation enhanced the linolenic acid content of egg yolk. In this study, the highest C18:1 concentration was found in the eggs of hens fed olive and canola oil, which were rich in C18:1. Similarly, the C18:2 concentration of the egg yolk was high in the groups fed soya bean and grapeseed oil, which are rich in C18:2. The highest C18:3 concentration of the egg yolk was found in the group fed canola oil, which is also rich in C18:3.

Discussion

Guclu *et al*. reported that quails fed a diet supplemented with sunflower and olive oil produced significantly heavier eggs. In another study, Kucukersan *et al.* reported that supplementing four different kinds of oil sources (sunflower, fish, soya bean and hazelnut oil) at 3% concentration had a significant effect on egg production and egg weight.

All these results are in contrast with the present study. In addition, it is indicated that supplementing fish oil and tallow at the level of 1,5% to the corn/soya bean meal diet may affect egg production performance and egg weight without any adverse effects on body weight.

In the present study, SFA content was not significantly different between the treatments, which are in agreement with other reports. Hens have the ability to synthesise SFA and if the values of their rations decrease, hens can compensate for the lack of these FAs.

Some studies have reported that the DHA and EPA concentrations of the egg yolk of birds fed diets containing fish oil is a reflection of the DHA and EPA concentration of fish oil. Reportedly, inclusion of fish oil in the diet could increase the proportion of n-3 PUFA relative to n-6 PUFA in the tissues of poultry.

There is competition among the enzymes involved in the elongation and desaturation of omega-3 and omega-6 FAs. Delta-6 desaturase is the critical enzyme in these reactions, for which the greatest affinity appears to be conferred by the greatest number of double bonds in the C18 substrate. Hence, using diets rich in omega-3 FAs (e.g. fish oil) reduces the omega-6 FAs content of egg yolk.

In conclusion, the results of the present study demonstrated that different oil sources had varying effects on the FA composition of egg yolk. This is reflected by the FA composition of the oils added to the diet. Based on the results, adding 3% fish oil to the diet of laying hens could increase the DHA and EPA content of egg yolk, with their consequent health benefits.

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Evidence of the health benefits **of canola oil**

By Lin Lin, Hanja Allemekinders, Angela Dansby, Lisa Campbell, Shaunda Durance-Tod, Alvin Berger, and Peter JH Jones

Canola oil-based diets have been shown to reduce plasma cholesterol levels in comparison with diets containing higher levels of saturated fatty acids. Consumption of canola oil also influences biological functions that affect various other biomarkers of disease risk.

Previous reviews have focused on the health effects of individual components of canola oil. Here, the objective is to address the health effects of intact canola oil, as this has immediate practical implications for consumers, nutritionists, and others deciding which oil to consume or recommend.

A literature search was conducted to examine the effects of canola oil consumption on coronary heart disease, insulin sensitivity, lipid peroxidation, inflammation, energy metabolism, and cancer cell growth. Data reveals substantial reductions in total cholesterol and low-density lipoprotein cholesterol, as well as other positive actions, including increased tocopherol levels and improved insulin sensitivity, compared with consumption of other dietary fat sources.

In summary, growing scientific evidence supports the use of canola oil, beyond its beneficial actions on circulating lipid levels, as a health-promoting component of the diet.

Introduction

Canola is a bright, yellow-flowering plant belonging to the Brassicaceae family. This family includes three different species: *Brassica napus, B. rapa,* and *B. juncea*. Originally from the Mediterranean area and Northern Europe, *B. napus* is commonly known as rapeseed. Rapeseed was identified in 2000 BC as a high-erucic acid crop, containing > 40% erucic acid in the oil.

Due to concerns over erucic acid content that stemmed from animal studies, high-erucic acid rapeseed oil used to be produced in North America solely in small quantities for industrial, non-food use. In 1976, however, Canadian scientists were able to improve the quality of previous cultivars of rapeseed through traditional plant breeding, which led to a conversion to commercially consumable canola cultivars.

In 1979, Canada registered the word 'canola' to describe a new seed found to be oil, which was low in erucic acid and low in glucosinolates. Canola has specific cut-off levels of erucic acid and glucosinolates for both human and animal consumption. In 1977, the low-erucic acid rapeseed oil containing < 5% erucic acid and low glucosinolates was introduced as an edible oil in Europe. In 1985, the Unites States Food and Drug Administration (USFDA) granted canola oil generally recognised as safe (GRAS) status as a dietary component.

Throughout this review, the term 'canola oil' is used to generically refer to the presently available conventional canola oil in North America and conventional LEAR oil in Europe. Other types of canola oil or LEAR are specifically noted.

Over the past 40 years, canola has become one of the most important oilseed crops worldwide. Today, canola oil is the third largest vegetable oil by volume after palm and soya bean oil. The worldwide production of canola oil in 2010/11 was 38 million metric tons, with Europe accounting for 63% and Canada accounting for 31% globally. In the United States (US), canola oil is one of the most widely consumed oils, second only to soya bean oil.

Assessing canola's health benefits

Canola oil is characterised by the following: low level (7%) of saturated fatty acids (SFAs); substantial amounts of monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs), including 61% oleic acid, 21% linoleic acid, and 11% alpha-linolenic acid; plant sterols (0,53 to 0,97%); and tocopherols (700 to 1 200 ppm), all of which have data indicating they are cardioprotective substances.

With regard to the high MUFA content of canola oil, evidence has been provided supporting positive effects of MUFAs compared with SFAs on cardiovascular health through the regulation of plasma lipids and lipoproteins, susceptibility of low-density lipoprotein (LDL) oxidation, and insulin sensitivity. Also, for the treatment of existing cardiovascular disease, canola oil has been recommended for achieving daily n-3 FA requirements of 1g/day.

Photograph by Keith Jones.

In 2006, the USFDA authorised the following qualified health claim for canola oil: "Limited and not conclusive scientific evidence suggests that eating about 1½ tablespoons (19g) of canola oil daily may reduce the risk of coronary heart disease due to the unsaturated fat content in canola oil. To achieve this possible benefit, canola oil is to replace a similar amount of saturated fat and not increase the total number of calories you eat in a day." This claim was based on the validity of total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels as biomarkers for coronary heart disease (CHD).

More recently, growing numbers of studies indicate that biomarkers beyond blood lipids are beneficially influenced by canola oil consumption. The objective of this review was to conduct a literature assessment to examine the health benefits of intact canola oil, rather than focus on the effects of individual components in the oil. This approach can be considered more practical since consumers make choices among intact cooking oils for consumption.

Further, this review investigated whether newer data is compatible with earlier conclusions regarding the health benefits of canola oil. The specific aim of this review, based on the most recent literature available, was to describe the effects of canola oil consumption on blood lipids, inflammation, insulin sensitivity, LDL-C oxidation, energy metabolism, and cancer compared with other dietary fat sources.

Effects on blood lipid profiles

SFAs are found in animal fat and dairy products as well as certain types of vegetable oils, including coconut and palm oils. Typical Western diets are high in SFAs. A high amount of dietary SFA may increase TC and LDL-C levels, thus increasing the risk of developing cardiovascular disease. Efforts to substitute SFAs have typically relied on replacement of animal fat and dairy products with liquid vegetable oils high in MUFAs and PUFAs.

Five studies compared canola oil-based diets with typical Western diets, providing evidence that canola oil is able to reduce TC levels by an average of 12,2%. Diets based on canola oil showed positive effects on TC levels regardless of the type of canola oil used compared to a typical Western diet. Seven studies compared canola oil-based diets with those high in SFAs. The high-SFA diets in these studies contained > 12% of energy from SFAs and > 30% of energy from total fat, mainly in the form of butter, margarine, mayonnaise, and other high-SFA foods. Five of the seven studies examined the effects of margarines or mayonnaises made with canola oil on TC levels and all showed a lowering of TC levels, in a range from 3,3% to 21,7%, compared with a high-SFA-treated group.

A group of subjects were fed diets containing canola oil or a high-SFA alternative rather than incorporating the oil into food products; their results demonstrated significant lowering of TC levels with the canola oil, at 8,3% and 15,5%, respectively, compared with the high-SFA alternative. Results from all seven studies consistently showed that replacing higher SFA diets with canola oil decreased TC levels.

Canola vs other vegetable oils

Five studies compared canola or high-oleic canola oil to other high-MUFA or high-PUFA vegetable oils, including a blend of flaxseed and high-oleic canola oils (50/50%) or maize, olive, or sunflower oils. Six studies examined the consumption of canola oil versus high-PUFA oils. In four of these six studies, sunflower oil was chosen as one of the control oils. No significant differences were observed between canola and sunflower oils on the extent of reduction of TC concentration compared to the baseline, resulting in the conclusion that sunflower oil can improve TC concentration as well as canola oil.

Three studies that selected olive oil as the control against canola oil resulted in TC concentration reductions of 12,2, 14 and 11,6% after consumption of canola oil compared to olive oil. Interestingly, the reductions in LDL-C achieved with canola oil were similar when compared with maize and sunflower oils or an oil blend of flaxseed and high-oleic canola oils. However, three studies showed a higher reduction of LDL-C concentrations with canola oil-based diets compared with diets using olive oil.

In vitro and in vivo studies

Not all dietary fats undergo equivalent partitioning for energy expenditure, and some may exhibit satiety promoting actions. To help individuals maintain normal body weight and prevent obesity, studies have examined food intake, satiety, body weight, body mass index, and body composition following consumption of different types of oils. Furthermore, dietary fatty acid composition plays an important role in metabolism and gene expression. Some studies have explored the possible actions of oleic acid-rich oils,

such as olive and canola oils, given older data suggesting preferential partitioning of oleic acid for oxidation versus retention in body storage compartments.

A few studies examined the direct actions of canola oil-based diets on human energy metabolism. For example, an analysis was done of the satiating effect of fat and its physiochemical properties in a double-blind, randomised crossover study. In this study, fat emulsions consisting of 6g of shea, canola oil, or safflower oil were each provided to 15 healthy subjects.

After four days, the canola and safflower oils significantly increased fullness and reduced hunger compared with the saline control treatment, but no effects on food intake were observed. Gut peptides involved in the regulation of satiety and food intake were also analysed in this study. This study concluded that canola oil can increase cholecystokinin levels, which may, in turn, mediate the satiating effects in the ileum.

Sensitivity and tolerance

Evidence has shown that SFA intake is linked with insulin resistance, obesity, and metabolic syndrome. In a review by Gillingham on the health benefits of MUFAs, it was concluded that MUFAs are capable of favourably modulating insulin sensitivity and glycaemic control when substituted for SFAs.

Canola is a yellow-flowering plant of the Brassicaceae family which includes the three species Brassica napus, B. rapa, and B. juncea.

Many dietary intervention studies have tested the effects that a substitution of SFAs with MUFAs or PUFAs has on insulin sensitivity. However, many other factors beyond dietary fatty acid composition may influence glucose tolerance and insulin sensitivity. In this arena, the focus has been on the clinical outcomes of canola oil-based diets on insulin sensitivity and glucose tolerance compared to diets higher in SFAs and unsaturated fatty acids. It was reported that there were lower levels of glucose and steeper glucose disappearance rates in participants who consumed a canola oil-based diet compared with a high SFA diet after an intravenous glucose tolerance test.

Canola has become one of the most important oilseed crops worldwide and canola oil is currently the third largest vegetable oil by volume after palm and soya bean oil. (Photograph: ID 50476719 © Stephan Bock | Dreamstime.com)

Canola oil and cancer risk

The association between lipid intake and various cancers has been understudied, particularly in humans. While no human clinical trials specific to canola oil and cancer have been performed to date, in vitro and in vivo animal data exist and are examined here.

Plant-based oils such as canola oil, which is a good source (11%) of ALA, have also been examined for their potential to modulate cancer cell growth and death. Protective effects of canola oil compared with maize oil against breast and colon cancers have been reported in various cell and animal studies; however, more research is required to provide definitive direction in this area.

A human case-control study, which determined that total fat intake was positively associated with breast cancer risk when adjustments were made for age, race/ethnicity, and total energy intake, were designed. Also, compared to women cooking only with olive or canola oil, those cooking only with vegetable or maize oil were at 30% increased risk of developing breast cancer. The overarching objective in these studies was to examine the association between dietary fat intake, cooking oil usage, and breast cancer risk in a population-based, multi-ethnic, case-controlled environment.

Among the fat components estimated from the food frequency questionnaires, including SFAs and oleic and linoleic acids, oleic acid was more strongly associated with breast cancer than was linoleic acid, whereas SFA intake failed to associate with breast cancer risk. To conclude, studies exploring linkages between canola oil consumption and cancer risk modification remain equivocal.

Conclusion

After 15 years of continuing research on canola oil since the latest review, evidence shows several potential health benefits of canola oil consumption. Canola oil can now be regarded as one of the healthiest edible vegetable oils in terms of its biological functions and its ability to aid in reducing disease-related risk factors and improving health.

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Census 2017: An overview of **commercial agriculture**

By Claudi Nortjé

The statistician-general and head of Statistics South Africa, or Stats SA, Risenga Maluleke, released the results of the Census of Commercial Agriculture (CoCA) 2017 in March this year. The general objective of the CoCA 2017 was to collect basic quantitative information on commercial agriculture in South Africa, which is essential for policy formulation and food security.

Farm income

The total income for the commercial agricultural industry in 2017 was R332,8 billion, which is significantly higher than the R85,9 billion recorded for 2007.

According to the CoCA 2017, there were 40 122 commercial farms in 2017. Farms with an annual income of more than R22,5 million constituted 6,5% of the total number of farms in commercial agriculture. These 2 610 farms accounted for 67% of total income and 51,4% of total employment.

Microfarms with an annual income below R1 million made up nearly half of the total number of farms (18 710), but only accounted for 1,9% of total income and 6% of total employment.

Gross farming income

The gross farming income derived directly from agricultural activities totalled R294,8 billion and consisted of animals and animal products (52,2%), horticulture (23,9%) and field crops (23,4%). Based on the number of farms recorded and the gross farming income of 2017, the average income per farm was R7,3 million.

Most farming enterprises farmed animals in 2017 (33,9%). These farms also reported the highest share of income (36,2%) compared to other farming spheres. Mixed farming took up 31,1% of the total number of farms and 28,6% of income.

Horticulture reported the highest percentage of income at 35,5%, but only had a share of 11,6% of the total number of recorded farms. In 2017, livestock farming, mixed farming and horticulture brought in R120,8 billion, R95 billion and R65,7 billion, respectively.

The Free State reported the highest number of farms in 2017 (7 951), followed by the Western Cape (6 937), North West (4 290), the Northern Cape (4 829), Gauteng (2 291), Mpumalanga (2 823) and Limpopo (3 054).

Although the Western Cape ranked second in terms of the number of farms, it made the highest contribution to the commercial agricultural sector's total income in 2017. The province brought in R64,3 billion, followed by the Free State (R46,9 billion), North West (R39,7 billion), Mpumalanga (R38,4 billion) and KwaZulu-Natal (R34 billion).

Table 1: Land use by province as at 30 September 2018.

Province	Total		Arable land		Grazing land		Other land	
	Hectares	% contribution	Hectares	% contribution	Hectares	% contribution	Hectares	% contribution
Western Cape	4 098 779	8,8	1 003 642	13,2	2 738 371	7,5	356 765	15,7
Eastern Cape	5 713 528	12,3	357 810	4,7	5 266 438	14,4	89 278	3,9
Northern Cape	17 229 260	37,1	671 400	8,8	16 358 215	44,8	199 643	8,8
Free State	7 636 020	16,4	2 454 122	32,2	5 161 833	14,1	20 062	0,9
KwaZulu-Natal	1 843 926	4	524 053	6,9	917 312	2,5	402 559	17,7
North West	5 323 682	11,5	1 118 509	14,7	3 474 878	9,5	730 294	32,2
Gauteng	385 317	0,8	180 349	2,4	197 878	0,5	7 088	0,3
Mpumalanga	2 467 007	5,3	943 163	12,4	1 177 535	3,2	346 307	15,3
Limpopo	1 722 938	3,7	361 341	4,7	1 244 477	3,4	117 119	5,2
South Africa	46 420 458	100	7 614 392	100	36 536 940	100	2 269 115	100

Table 2: Field crops: Area planted and production in 2007 and 2017.

Type of crop	Planted hectares						Production in metric tons					
	Total		Dry land		Irrigated		Total		Dry land		Irrigated	
	2007	2017	2007	2017	2007	2017	2007	2017	2007	2017	2007	2017
Maize	2 156 766	2 173 371	1 952 218	1 943 828	204 548	229 542	7 373 033	10 801 025	6 034 723	8 824 995	1 338 308	1 976 030
Soya beans	107 124	470 169	93 895	440 372	13 228	29 796	177 765	842 549	143 378	753 428	34 386	89 121
Sunflower seeds	241 187	355 660	231 081	352 992	10 105	2 667	296 524	555 994	278 522	549 977	18 002	6 017
Wheat	563 888	325 909	470 497	237 974	93 390	87 935	1 603 872	1 011 704	1 125 491	577 692	478 381	434 012
Sugarcane	267 604	186 483	206 382	149 581	61 221	149 581	15 710 713	7 534 550	10 933 078	5 002 579	4 777 634	2 531 970

Employment

The CoCA 2017 report indicates that employment within commercial agriculture declined compared to employment levels in 2007. The total number of people employed within the sector on 30 June 2018 was 757 628, which is 11 966 or 1,6% fewer people compared to recorded totals in 2007. While an unfortunate fact and given that agriculture is one of the major creators of jobs in South Africa, this is a reflection of the general employment trend in the country.

South Africans employed in horticulture (268 740 people) made up most of the major commercial agricultural activity in 2017, followed by mixed farming (185 863 people) and farming of animals (162 116 people).

The Western Cape employed the most people within the commercial agricultural sector (186 997 people), followed by Limpopo (97 478 people) and KwaZulu-Natal (96 206 people). Gauteng and the North West province had the lowest employment levels within the commercial agricultural sector, with 36 517 and 57 758 people, respectively.

Commercial agricultural land use

According to the survey, 37,9% of the total land area of South Africa (122,5 million hectares) was used for commercial agriculture, which totals 46,4 million hectares.

Commercial agricultural land mainly consisted of grazing land (36,5 million hectares), which is used for game and livestock farming, and arable land (7,6 million hectares), used for crop production. The Northern Cape, Eastern Cape and Free state accounted for 73% of grazing land. The Free State, North West, Western Cape and Mpumalanga accounted for 72,5% of arable land.

Ultimately, the largest share of the country's commercial agricultural land is located in the Northern Cape (37,1%), followed by the Free State (16,4%), the Eastern Cape (12,3%) and North West (11,5%). Gauteng (0,8%) and Limpopo (3,7%) recorded the smallest shares.

Field crops

Field crops account for the largest portion of cultivated land in South Africa. In terms of area planted, the major field crops in both 2007 and 2017 were maize, soya beans, sunflower seeds, wheat and sugarcane. Between 2007 and 2017, the area planted increased in three cases, namely maize, soya beans and sunflower seeds.

All major field crops were mostly planted under dry land. In 2017, sunflower seeds had the highest proportion (99,2%) planted under dry land, followed by soya beans (93,7%), maize (89,4%), sugarcane (80,2%) and wheat (73%).

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Against whom **is a land claim really made?**

By HJ Moolman, Moolman & Pienaar Incorporated

Land claims are part and parcel of South Africa's land reform programme, authorised by Section 25 of the *Constitution of the Republic of South Africa, 1996 (Act 108 of 1996,* or the *Constitution).* The primary purpose of land claims is to bring about recovery or compensation for persons who, on the one hand, have been deprived of land-related rights as a result of race-based legislation and practices. On the other hand, it is aimed at securing tenure or achieving a balance in the racial composition of people who own land and/or have access to land through a programme of land redistribution.

Applicable legislation

The most important legislation permitting land claims is the *Restitution of Land Rights Act, 1994 (Act 22 of 1994,* or the *Restitution Act)* and the *Land Reform (Labour Tenants) Act, 1996 (Act 3 of 1996,* or the *Labour Tenants Act)*.

Claims under the *Restitution Act* must have been filed with the Commission on Restitution of Land Rights on or before 31 December 1998. Claims under the *Labour Tenants Act* must have been filed with the Department of Rural Development and Land Reform as prescribed, on or before 31 March 2001.

Against the state or the landowner?

A question that often arises during discussions about land reform is who is, in fact, the party against whom a land claim is being lodged? The perception and probably the first response to this question, is that it is a claim against the existing owner of the claimed land. In practice, this is also the experience of many a landowner.

The fact, however, is that land claims are filed against the state within the framework of existing legislation. Because the state is the respondent in respect of land claims, it must meet or settle the claims, depending on their scope and validity. This duty resting on the state, is a constitutional and statutory one.

> The fact is that land claims are being filed against the state within the framework of existing legislation.

The state's fulfilment of the abovementioned obligation only has consequences for private land and private landowners in such cases where the state must use specific private land to meet its obligation to pay or settle a claim. This also applies where the limited rights of tenant labourers on private land are converted into full-title rights because the tenant labourers occupied, cultivated and grazed the land.

Compensation vs expropriation

In cases where private land is compromised during the settlement of land claims, the state must acquire the land from the existing private owner. The *Constitution* places an obligation on the state to compensate the owner fairly and equitably.

The state's obligation to pay fair and equitable compensation for private land causes the state, for the purposes of settling a claim, to acquire the land through a negotiated purchase agreement or, alternatively, a more forced process known as expropriation. This is also why the issue surrounding the proposed amendment to the *Constitution* to allow for expropriation without compensation under certain circumstances, is currently such a contentious one.

Obstacles during negotiations

In the case of claims lodged under the *Restitution Act*, in addition to acquiring private land to settle claims, the state also has the right to offer alternative state land and/or cash compensation. There are several court cases in which the courts have clarified the circumstances in which the state, rather than acquiring private land, should settle claims by making alternative state land available or by paying a cash compensation.

One of the main reasons why private land would not be considered an appropriate method of settlement, is the underlying principle that claimants should not benefit more from the settlement of a claim than what they lost when they were deprived of their rights in the past.

Private landowners need to be extremely cautious when conducting any settlement negotiations in cases where their land may be compromised as a result of the abovementioned circumstances. Currently, several pieces of legislation have an influence on the manner in which the state should proceed in dealing with such matters.

In most cases, it will be wise to be accompanied by a legal representative at all times during negotiations with the state. It should preferably be someone who has a good basic knowledge of the relevant legislation and the legal environment in which these claims are handled.

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