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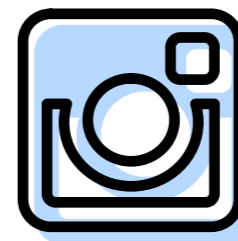
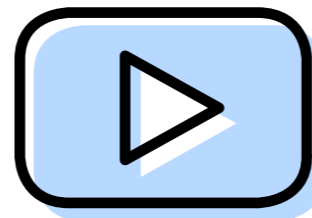
**the big thirst
summary report**

HORTGRO

Growing Fruit IQ

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TECHNOLOGIES



for minimising physiological disorders in apples

*talk by Prof Randolph Beaudry
summary by Anna Mouton*

Professor Randolph Beaudry from Michigan State University in the USA discussed factors that impact postharvest apple quality. He presented research results that suggest ways to avoid losses due to physiological disorders.

BEAUDRY began by reminding the audience that, although apples are stored, they are not storage organs. At harvest, apples lose all access to water and nutrients. “We reduce the temperature, we put them in the dark, and we remove the oxygen. What’s not stressful about that?” asked Beaudry.

According to Beaudry, fruit development is a continuous process and maturity represents more than one aspect of development. Degree of maturity plays a role in several disorders: softening, water core, superficial scald, soft scald, soggy breakdown, carbon dioxide injury, and senescent browning and lenticel breakdown. Therefore, consider maturity when making decisions about storage.

“There’s a harvest window for every apple variety during which the quality peaks,” said Beaudry. Climate change shifts this window by affecting the growing degree days. A rapid increase in the rate

of growing-degree-day accumulation at the time of harvest can result in poor storability. Different apple maturity indices are not synchronous, complicating harvest decisions.

“Apples always require ethylene to continue ripening,” said Beaudry. Treatment with SmartFreshSM—1-methylcyclopropene (1-MCP)—is most effective when applied early, but there is still a significant improvement in firmness when fruit are treated late compared to no treatment. Whereas SmartFreshSM blocks the action of ethylene, ReTain (aminoethoxyvinylglycine) stops the fruit from producing ethylene. Applying ReTain three to four weeks before harvest delays maturation, creating a longer harvest window.

Pre-harvest application of ReTain combined with postharvest treatment with SmartFreshSM significantly improves firmness retention over use of either treatment in isolation. This was true even when

fruit were harvested late.

There are many factors that affect storage decisions. “Every variety has its own optimal temperature,” explained Beaudry. “Some cultivars are chilling-sensitive. Temperatures below 3°C—or even 5°C—are damaging.” These varieties are susceptible to soggy breakdown and soft scald. Other than careful timing of the harvest, preconditioning is the main tool for controlling disorders caused by chilling. Preconditioning, also known as cooling delay or delayed storage, involves maintaining fruit at a higher temperature than the final storage temperature between harvest and cold storage. Preconditioning and storage at 3°C rather than 0°C can reduce soggy breakdown and soft scald, but may induce more bitter pit.

Soggy breakdown is highly variety-dependent and increases with maturation. Preconditioning (five to seven days at 10°C to 20°C) and elevated storage temperatures suppress soggy breakdown. Diphenylamine (DPA) reduces soggy breakdown slightly. Controlled atmosphere storage and treatment with SmartFreshSM has no effect.

Soggy breakdown and soft scald may occur together. Soft scald is affected by the same factors as soggy breakdown, but can in some cases be reduced by treatment with SmartFreshSM. Moisture

“Storage environments are stressful—fruit are biologically ‘designed’ to be consumed, not stored.”

loss is another problem of certain apple varieties. The relative humidity in a storage room decreases with an increase in the difference between room and coil temperature. The lower the relative humidity, the greater the moisture loss in the fruit.

Storage technologies that affect fruit quality include controlled atmosphere—standard, ultra-low oxygen, initial low oxygen stress and dynamic—and treatment with SmartFreshSM. Beaudry presented data on the effect of 1-MCP treatment on firmness in apples stored at 20°C. “Untreated fruit soften. If you treat them once, you get about 40 days before the fruit begin to soften.” More frequent treatment extends this period. However, there is a reduction in titratable acidity with long storage periods.

Beaudry stressed that both oxygen and carbon dioxide affect storage disorders. Elevated carbon dioxide and low oxygen suppress ethylene action, thereby slowing softening, respiration and loss of sugars and titratable acids. Standard controlled atmosphere (oxygen levels of 1.5 to 3.0 percent and carbon dioxide levels of 2.0 to 3.0 percent) don’t allow for longer-term storage. Ultra-low oxygen storage (oxygen levels of 0.5 percent) maintains apple quality better than standard conditions.

“Ultra-low oxygen storage basically requires all the same equipment but tighter rooms,” said Beaudry. “It works well with 1-MCP and can provide year-round storage.” Beaudry recommends ultra-low oxygen for most storage operations. Initial low-oxygen stress is a modification in which apples are exposed to oxygen levels below 0.5 percent for a limited time. Initial low-oxygen stress protects against the development of

superficial scald.

“Dynamically controlled atmospheres use the idea that you don’t just set it and forget it,” explained Beaudry. “You manipulate the oxygen and carbon dioxide concentrations during storage.” Oxygen levels are kept just above the level at which the apples show stress. Stress manifests as a measurable increase in chlorophyll fluorescence. Other stress indicators, used to detect fermentation, are ethanol levels and the respiratory quotient (estimated from oxygen and carbon dioxide levels).

Advanced systems for atmospheric control don’t provide better firmness retention than regular controlled atmosphere combined with application of SmartFreshSM. However, internal browning may be reduced. Apples stored without SmartFresh treatment may also qualify for organic status.

Beaudry considered carbon dioxide injury to be more common than low oxygen injury. Apple varieties differ in their susceptibility to carbon dioxide injury. Injury risk decreases with maturation. It is controlled by DPA and minimised by conditioning. Low oxygen levels and application of 1-MCP can exacerbate carbon dioxide injury. Damage usually occurs early in storage.

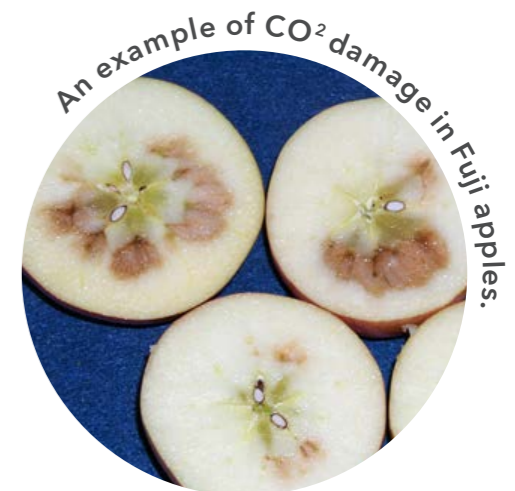
“You want to assess stored fruit on a regular basis,” Beaudry reminded the audience. The timing of monitoring depends on an assessment of fruit storability. When carbon dioxide injury is a concern, sample fruit at two to three weeks. For chilling injury, do the first evaluation at one to two months; after a warm season, evaluate at two months. During long-term storage, check the fruit at four, six and nine months. Sample untreated fruit a month later than fruit treated with ReTain or HarvistaTM (1-MCP). •



Soggy breakdown in a Honeycrisp apple.



Soft scald in a Suncrisp apple.



An example of CO₂ damage in Fuji apples.

THE PHYSICS OF WATER:

Understanding the basics of humidity

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*talk by Dr Marius Huysamer
summary by Anna Mouton*

Dr Marius Huysamer is a postharvest physiologist. His talk focused on the interaction between humidity and moisture loss in fruit.

HUMIDITY is a measure of the amount of water vapour in the atmosphere. "If we want to talk about humidity, we first need to understand what happens in air," said Huysamer. Dry air contains 78 percent nitrogen, 21 percent oxygen and less than one percent each of carbon dioxide and the noble gases. Moisture in air accounts for one to four percent of total air volume.

"At sea level and 20°C there are about 25 septillion molecules in a cubic meter of air," observed Huysamer. "That's 25 times ten to the power of 24." The total mass of molecules per volume of air represents the density of that air. Density increases when temperatures fall and pressures rise. "If you take the same volume of air, but at different temperatures, the warm air will contain fewer molecules than the cold air," explained Huysamer.

At temperatures above absolute zero (minus 273°C) water molecules have energy and vibrate. The more energy, the faster the vibration and the higher the temperature of the water. "Changes in phase, from solid ice to liquid water to a gas [water vapour], are a function of energy," noted Huysamer.

“Cold-room humidity is an important determinant of moisture loss during storage”.

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Specific humidity—absolute humidity or mixing ratio—is the mass of water vapour present per unit mass or volume of air. As specific humidity increases, the air becomes more saturated until rates of evaporation and condensation are equal: the air cannot hold any added water vapour. This point is temperature dependent. “Cold-room air at 0°C cannot contain more than five grams of water per cubic meter,” stressed Huysamer. “And that’s dry!”

Relative humidity represents degree of saturation expressed as a percentage. Because the amount of water in saturated air is temperature-dependent, specific humidity cannot be inferred from relative humidity unless temperature is known.

Huysamer demonstrated the use of the psychrometric chart (a graphic representation of the relationship between specific humidity, relative humidity and temperature). He also pointed the audience to an [online resource for humidity calculations](#). Users can enter temperature, relative humidity and pressure (Huysamer used 1010 hectopascal which is equivalent to atmospheric pressure at sea level) and the calculator will return variables such as specific humidity, dew point and water vapour pressure.

Water vapour pressure is important in

understanding moisture loss from fruit. The intercellular air space inside the fruit is saturated with water vapour. Because relative humidity outside the fruit is less than 100 percent, the vapour pressure deficit between fruit and atmosphere drives moisture loss through diffusion of water vapour from a region of high pressure (inside the fruit) to a region of lower pressure (outside the fruit). “As relative humidity increases, there is a reduction in water vapour pressure deficit,” said Huysamer. “At any given relative humidity, the vapour pressure deficit – and subsequent rate of moisture loss – is much lower at 0°C than at higher temperatures.”

“The bottom line is, at any relative humidity, cooler is better,” said Huysamer, “and the temperature effect becomes larger the lower the relative humidity.” During harvest, fruit experiences extreme conditions with relative humidity as low as 25 percent and temperatures of 30°C or higher. “Water vapour pressure deficit can be thirtyfold greater than under cooling,” warned Huysamer. “It shows how critical it is to get your fruit into a cold-room as soon as possible.”

Cold-room humidity is an important determinant of moisture loss during storage. “Let’s look at a poor cold-room –80 percent humidity. The vapour pres-

sure deficit is four times greater than in a cold-room at 95 percent humidity,” said Huysamer. “This is why maintaining humidity at 95 percent is so critical for long-term storage.” Huysamer believes that saving money on cold-room installation is a false economy.

Huysamer presented data on the effect of post-harvest cooling on vapour pressure deficit. Vapour pressure deficit is highest when warm fruit are first chilled, due to the low moisture content of cold-room air and the high vapour pressure in warm fruit. Once the fruit reaches final storage temperature, vapour pressure deficit is low. Both a delay in cooling and a slow rate of cooling can cause excessive moisture loss.

Reducing the time between harvest and cold-storage is likely to yield greater benefits than trying to increase the relative humidity in shipping containers. “Before the industry hasn’t addressed moisture loss at the farm level, it’s not going to help to try and modify containers,” concluded Huysamer. “If you want to spend money, buy more bin-trailers, or employ more staff, and get your product to the cold-store faster.” •

THE OPPORTUNITIES and challenges of pre-sorting

*talk by Jaco Moelich
summary by Anna Mouton*

Jaco Moelich, product technical manager at the Fruitways Group, provided insights on the technical aspects of pre-sorting in apples. Fruitways are industry leaders in the packing and marketing of apples and pears.

“I’M not here to convince you that pre-sorting is either better or worse than commit-to-pack,” said Moelich in his opening remarks. “I’m merely sharing our experience.”

“Pre-sorting is to sort fruit into size, grade and colour groups, and then to put it back in some bulk format before you pack or process it,” explained Moelich. “Pre-sorting can be done before or after long-term storage.” In contrast, commit-to-pack involves sorting fruit into size, grade and colour groups at the same time as packing in the final format.

Moelich discussed the advantages of pre-sorting in the context of harvesting, storage, packing and marketing. During harvesting, pre-sorting reduces the need for culling at farm-level in the orchard. Referring to a photo of workers bent double over a harvesting bin,

Moelich said, “That is not a very comfortable position to be in. It’s difficult to be accurate and not damage other fruit in the bin. Pre-sorting provides the opportunity to improve that process significantly. But it’s not cheaper.”

When it comes to storage, pre-sorting helps identify those fruit for which long-term storage is not financially justified. South African apples tend to be variable. “We’ve got some varieties that have relatively low Class 1 pack out. On those varieties the advantages of pre-sorting before storage are much greater. You can avoid high storage costs on the lower grade fruit,” advised Moelich. Reserve expensive cold storage and treatments like 1-MCP (1-methylcyclopropene) for high-value fruit.

Pre-sorting also offers benefits during packing. “When you have your fruit pre-sorted in groups—all uniform—your packing is much

more efficient. You can set up your production teams to be very cost-effective,” said Moelich. “However, your capital layout is greater than in commit-to-pack.”

Regarding marketing, Moelich believes the biggest opportunity offered by pre-sorting is the ability to market different groups of fruit at the ideal time. Pre-sorting enables a rapid response to changing market conditions and client requirements. “If your client has a desperate need and the money’s right, you can pack a certain specification of fruit in a very short time. Your reaction time is much quicker.”

But there are challenges associated with pre-sorting. “I can assure you: these challenges that I’ll be talking about are just a few,” Moelich warns the audience. “I could probably have made the list five times longer.”

“When you have your fruit pre-sorted in groups your packing is much more efficient.”

The additional handling of fruit in a pre-sorting system elevates the risk of cold chain breaks and damage. Rebinning fruit with injuries or bruising can cause significant problems. “You need top-class equipment which is usually very expensive,” stresses Moelich. “If you’re not careful, you can very quickly have negative effects on fruit quality.”

Pre-sorting promotes storage complexity. “In commit-to-pack, your complexity lies in your carton management and it’s the marketer’s problem. He must sell that fruit. With pre-sorting, we’ve moved the complexity to the bin area.” Moelich calculated that a pre-sorting operation deals with ten times as many product variables as a commit-to-pack business.

“You need to be on top of your bin stock management,” emphasised Moelich. Marketing of fruit needs to take differing quality retention during storage into account. Post-harvest defects are yet another potential cause of losses. Moelich highlighted the importance of good water sanitation in preventing the development of defects during storage. “When you put fruit through water and afterwards into long-term storage, you really increase your risks for rots and other problems.”

Pre-sorting systems also present challenges during marketing. The marketing team has to have accurate marketing intelligence to predict demand. The production and marketing teams need to work closely together to ensure a quick response to requests from clients. A flexible packing operation is essential to reap the benefits of pre-sorting. “More often than not, we plan a week ahead,” said Moelich, “just for the order to change a day before packing.”

“Pre-sorting has some significant technical challenges that should be well-understood,” concluded Moelich, “so if you are considering pre-sorting, understand exactly how it fits in with your business philosophy.” •



LENTICEL

disorders on apples: The impact of cooling on lenticel damage

talk by Dr Ian Crouch
summary and illustrations by Anna Mouton

Dr Ian Crouch, research and development director at ExperiCo, explained the different types of lenticel disorders on apples and summarised the best practices for avoiding these.

"AS a postharvest physiologist, I get many calls about lenticel breakdown," said Crouch. "It's important to recognise the different types of lenticel disorders on apples." Crouch described six disorders that could be confused: bitter pit; blister pit; Jonathan spot; chemical burn; lenticel spot or breakdown; and lenticel blotch or blotch pit.

Bitter pit

- Spots on surface are initially highly coloured but then become grey, brown or black
- Spots sink in a round or slightly angular pattern
- Flesh under spots is corky (dry, brown and spongy)
- Physiological disorder that begins on the tree but manifests during storage
- Worse in light crops from young trees; larger apples; apples picked when immature
- Increased by irregular watering; heavy application of nitrogen; heavy pruning and thinning; magnesium nitrate
- Reduced by calcium nitrate



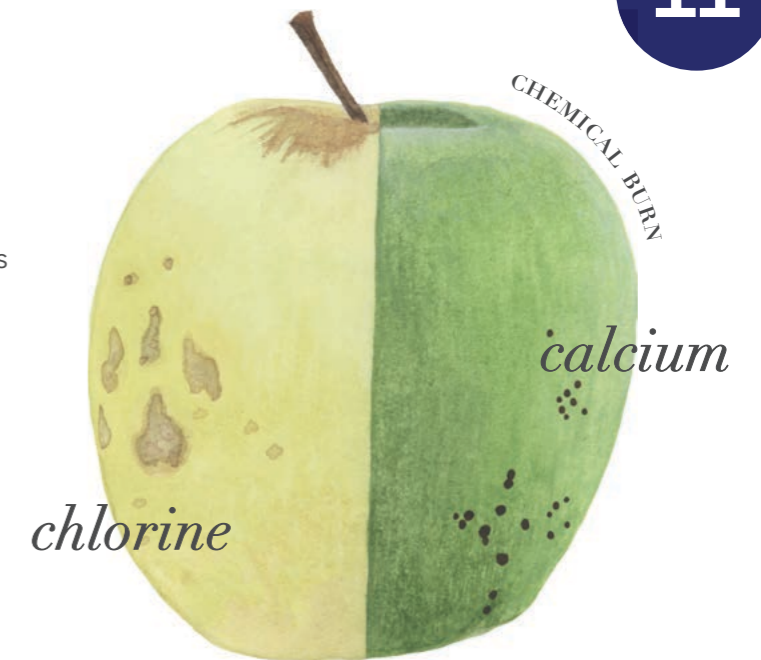
Blister pit

- Small raised blisters on the surface appear as brown spots
- Caused by a bacterial infection (*Pseudomonas syringae*)
- Not common in South Africa



Chemical burn

- Chemical damage can be confused with lenticel disorders
- Caused by both pre- and postharvest chemicals
- Chlorine drench blemishes skin but damage is not restricted to lenticels
- Calcium application affects lenticels and manifests as clusters of small, black or brown spots



Jonathan spot

- Spots on surface originate at lenticels which become dark brown or black
- Spots may be slightly sunken with a surrounding halo
- Flesh under spot may be corky (dry, brown and spongy)
- Worse after a dry season; on larger apples; in late-harvested fruit; when fruit are cooled slowly
- Cause is unknown



Lenticel spot or breakdown

- Spots on surface are round; sunken; centered on a lenticel; and sharply defined
- Spots become deeper and larger over time and may coalesce
- Flesh under spot is not affected – differs from bitter pit and Jonathan spot
- Appears on less exposed side or colour margins of fruit
- Physiological disorder affected by pre- and postharvest factors and manifests after storage



Lenticel blotch or blotch pit

- Spots on surface have an irregular outline – differs from round spots in lenticel spot
- Spots are centered on a lenticel and become sunken
- Flesh under spot is brown – similar to bitter pit and Jonathan spot
- Appears on calyx or more exposed side of fruit – differs from lenticel spot
- Physiological disorder that begins on the tree but manifests during storage



Crouch presented results of a cooling trial conducted with Golden Delicious apples. Fruit packed directly in boxes, without bags, cooled fastest. The speed at which fruit in bags cooled depended on whether the bags were perforated and the size of the perforations. Non-perforated bags slowed down cooling and larger perforations promoted more rapid cooling. Fruit packed in non-perforated bags had less lenticel spot but more bitter pit than other treatments.

According to Crouch, the increased bitter pit can be explained by the higher levels of ethylene trapped in the bags. This research indicated that additional cooling stress after packing may increase expression of lenticel disorders and that care should be taken in the rate of cooling of lenticel sensitive cultivars.

Researchers and industry have put together a best-practice guide for lenticel-damage mitigation. "Evidence shows that lenticel damage can be related to moisture loss," said Crouch. "All practices that prevent moisture loss will have a beneficial effect." Crouch shared the best practices with the audience.

At harvest

- Harvest each cultivar at optimum maturity
- Deliver bins within 12 hours (preferably six hours)
- Limit exposure to high temperatures after picking
- Fruit at risk of developing lenticel disorders should only be stored short-term in controlled atmosphere, followed by 10 days at regular atmosphere, and sorted before packing.

Prior to storage

- Move fruit from loading areas to cold stores as soon as possible
- Do not apply calcium postharvest to sensitive cultivars (Braeburn, Fuji and Kanzi).

Step-down cooling

- Use a seven-day gradual step-down cooling period
- Do not cool below the recommended temperature for the cultivar.

Storage

- Market fruit from warmer orchards (north-facing, sandy soils or warm area) earlier in the season
- Fruit at risk of developing lenticel disorders should only be stored in regular atmosphere or short-term controlled atmosphere to allow development before sorting
- Wait ten days before packing fruit from controlled atmosphere storage, to allow development of lenticel disorders before sorting.

Packaging

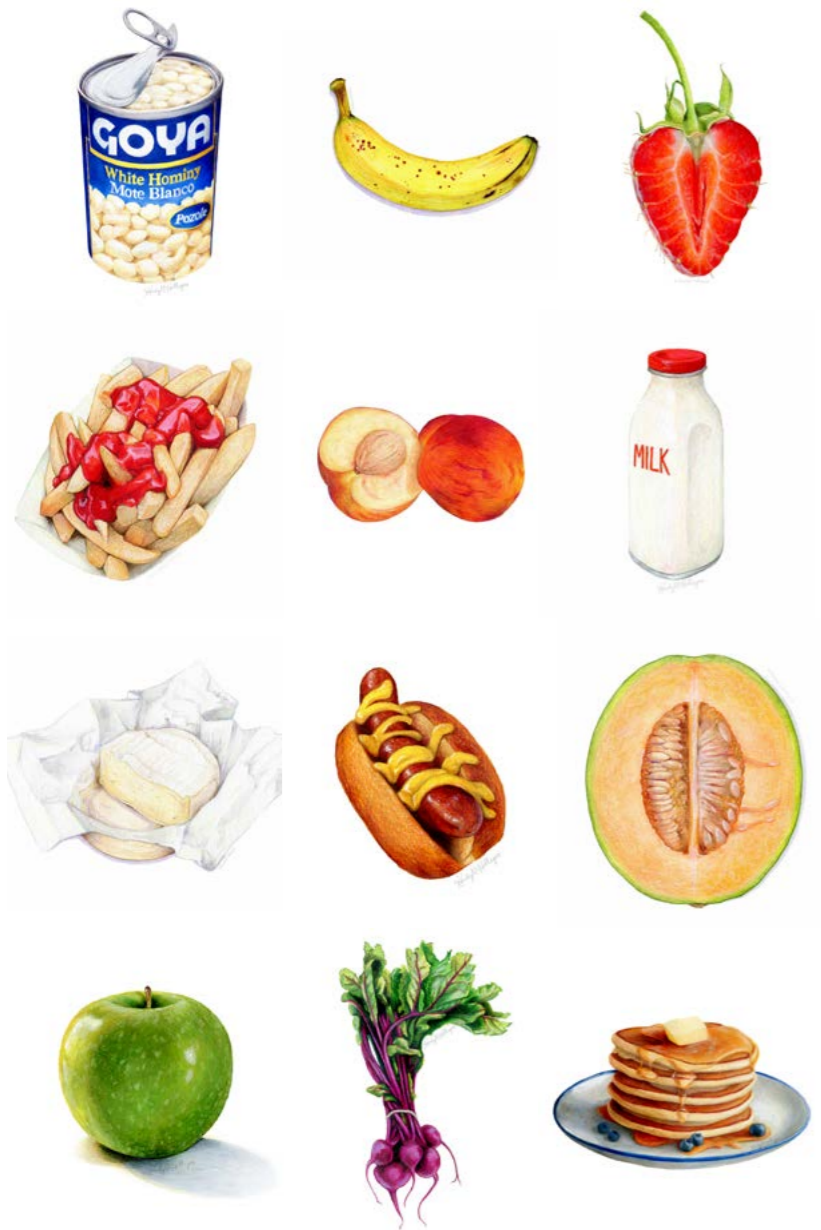
- Use micro-perforated bags.

Crouch pointed out that the recommendation on packaging may be revised following recent research results. "What's important," concluded Crouch, "is to not stress the fruit." •

PREVENTION IS BETTER THAN CURE:

Food safety and the consumer

*talk by Dr Corné Lamprecht
summary by Anna Mouton*



“Are we ready to face new microbiological challenges?” was the question posed by Dr Corné Lamprecht from the Department of Food Science, University of Stellenbosch.

“IN order to stop food-borne illness, we have to stay vigilant, evaluate current strategies and adapt when necessary,” stated Lamprecht. She shared figures from an article published in The Lancet in 2016. The authors summarised data on major causes of death worldwide between 1980 and 2015. Conditions linked to food and water safety, particularly diarrhoeal diseases, result in significant loss of life, especially in developing countries. Diarrhoea strikes approxi-

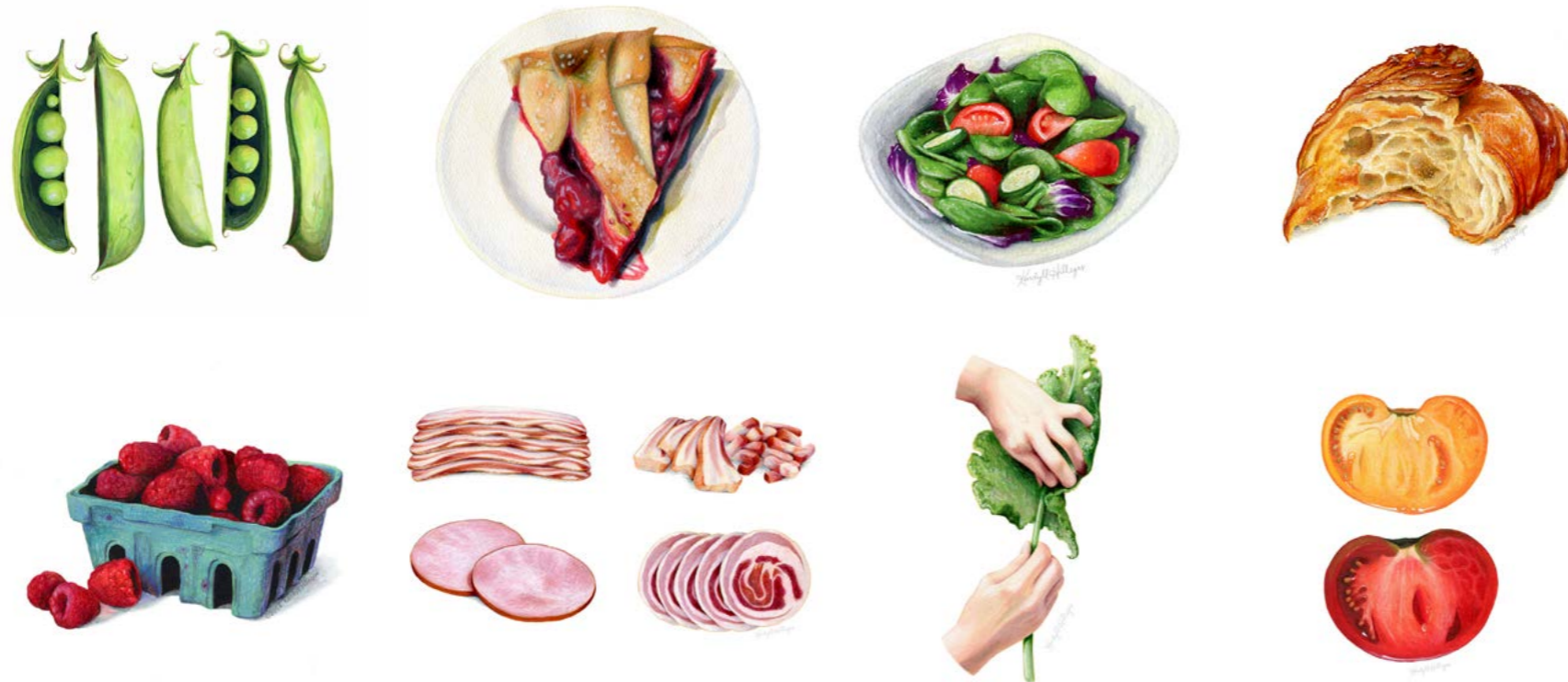
mately 1,000 million young children every year, killing about 525,000 of them.

Lamprecht also highlighted the importance of food security. “The world faces a potential crisis. By 2050, the world’s population is predicted to reach 9 billion, which may increase the demand for food by 70 percent and double the demand for water. Food spoilage and wastage as well as an increase in food safety risk will become very important issues. We will need to produce more food – more safe

food – with fewer resources.”

Food safety problems are challenging and complex, according to Lamprecht. “It is not a commercial option to fail. Linking a product to consumer illness can be catastrophic for the processor.” Losses due to foodborne disease include the economic impact of product recalls and reputational damage.

“There’s an increase in emerging pathogens and we’ve also seen greater antimicrobial resistance,” cautioned Lamprecht. “In order to counter these



pathogens that are continuously adapting to our strategies, the process of food safety has to be dynamic." As demand for convenience foods grows, consumers become more reliant on producers and processors for safe food. Ready-to-eat foods are high-risk because they do not undergo further processing at home.

Lamprecht showed data on the occurrence of food-related illness in the United States of America. Four groups of bacteria stand out: *Campylobacter*, *Salmonella*, *Listeria* and *Escherichia coli*. *Listeria* infection is rare, but more likely to result in death than infection by the other three. "South Africa holds the record for the biggest *Listeria* outbreak," said Lamprecht, "but it is a problem worldwide."

Lamprecht outlined the main characteristics of listeriosis. In healthy adults, *Listeria* infection is usually limited to the gut and the person may show little sign of illness. Susceptible people – pregnant women, babies, the elderly, those with weakened immune

systems – can develop the invasive form of *Listeria* infection where the bacteria enter the bloodstream and spread around the body. There are many species of *Listeria*, but Lamprecht explained that only *Listeria monocytogenes* and *L. ivanovii* cause disease.

"*Listeria* is a down-to-earth pathogen," said Lamprecht, "it occurs everywhere and grows on anything dead." Most bacteria that cause foodborne disease cannot multiply in cold conditions, but *Listeria* proliferates even under refrigeration. Freezing will halt growth but not kill *Listeria*. *Listeria* can colonise factory environments and resist removal and disinfection. *Listeria* is especially common in factory drains, from where it can spread to contaminate food products.

Lamprecht pointed out that the globalisation of the food trade compounds food safety risks. Hazards can enter the food chain at any point and the centralisation of food production then facilitates widespread outbreaks of illness. An example is the 2011 *E. coli* outbreak in Germany that was linked

to fenugreek seeds imported from Egypt. The same contaminated seeds also caused *E. coli*-related illness in France.

The main practices that lead to foodborne disease in South Africa are improper temperatures for cooking, refrigeration and freezing; poor personal hygiene; cross contamination between foods; and contaminated irrigation water.

"Safe preparation of food at home is the last line of defence for preventing foodborne illness," Lamprecht stated, "but that's not an option when working with ready-to-eat foods."

For food processors, safe practices come down to proper cleaning; preventing cross-contamination; correct cooking and chilling temperatures; and using good-quality ingredients. Factories need to monitor pathogens such as *Listeria* and, when present, address them in their HACCP (Hazard Analysis Critical Control Point) programs.

Lamprecht concluded on a positive note, "If there's one good thing that has come from the *Listeria* crisis, it's increased communication between industry and academia. We shouldn't stop here: we should keep communicating to make sure that academic research is of practical relevance to industry." •

Illustrations by Kendyll Hillegas, www.behance.net/kendyll

THE TRAITS

of a successful farmer

talk by Bun Booyens
summary by Esté Beerwinkel



What makes a successful farmer? Is it hard work, entrepreneurial flair or great foresight? According to kykNET's Megaboere presenter and veteran journalist Bun Booyens, it's this and much more.

AFTER studying 13 progressive *megaboere*, Booyens found these farmers share many common traits. He says these farmers:

- understand risk,
- know how to negotiate,
- form "knowledge" partnerships,
- believe empowerment is vital,
- understand the value-chain,
- experienced a crisis in their lifetime,
- have a unique perception of a time horizon,
- are true entrepreneurs, and lastly
- have neat "yards".

Booyens says the most crucial characteristic mega farmers share, is that they understand and can quantify risk. "Although these farmers hope and pray for rain, they know how much rain will fall and plan accordingly-they quantify risk down to the third decimal."

Being a "hardegat" negotiator is an essential skill for these mega farmers. "Some of the toughest bargainers are in retail. These farmers will tell you the most difficult thing they've done is getting their produce to market via supermarkets." Booyens tells the story of Malmesbury farmer Neels Neethling of Saamstaan-boerdery. "Neels is an exam-

ple of an excellent negotiator. Twice a day his 4 000 piece cattle get milked and produce 130 000 litres of milk—all of which goes to Clover. Better yet, this is a 16-year deal with Clover. Neels owns no trucks, Clover hauls the milk from his farm to where they need it. This isn't only an example of great negotiation skills, but his operation scarcely has risks."

Many of the farmers Booyens visited has some form of partnership. However, he says, they weren't all direct partnerships. "Business partnerships are often about money, but in farming it is partnerships of knowledge and skills—access to geneticists, financial management skills and more."

Throughout his presentation Booyens mentions the importance of empowerment on each of the mega producers' farms. "I haven't met one *megaboer* who doesn't think empowerment isn't vital. I was on their farms, I drove with them in their bakies, and ate dinner with them—their models of empowerment set the benchmark, and it's heartening to see people who've been in the game a long time have a change of heart."

He believes the Bosman brothers' Bosman Adama operation on Lelienfontein, Wellington is an example of this. "The Bosmans have been around for 200 years, and the eighth generation who now runs the farm say their labourers have been with them through all of it. Thus, they created a fifty-fifty part-

nership trust. This trust provides according to the workers' needs—they needed an on-farm crèche and school, and now they have it. The Bosmans believe you have to speak to people and understand first-hand what their real needs are.

"At Fairview in Paarl, Charles Back surveyed his workers and employed an industrial psychologist, this exercise demonstrated only one of 40 workers want to farm on their own land; the workers wanted a secure roof over their heads, peace of mind when they retire, their health needs cared for, and a better life for their children. Charles made his workers majority shareholders in his cheese factory, and created adjacent non-farm related businesses, which are run by his workers."

The ClemenGold brand's "father" Abraham van Rooyen, believes informing workers forms part of empowerment, Booyens says.

"Abraham's workers receive "comic book contracts". It provides all tasks, expectations and information in a picture format so there isn't any confusion or assumptions made—he also doesn't have many labour issues."

According to Booyens, understanding the value-chain cannot be underestimated.

"*Megaboere* know when to get on-board. Bosman Adama's Petrus Bosman believes in "running for the gaps", don't go where everyone else is going.

"Carpe Diem Estate in Upington took a risk when they converted their raisin, pecan nut, and table grape operation to an organic setup. Not only do they have better quality products now, they also get a 50% higher price for their produce—they ship to EU markets, and realised the Europeans prefer organic produce."

Booyens also shares the story of the Sernick Group in Kroonstad's Nick Serfontein, and emphasises that Serfontein is a value-chain guru. "Nick's motto is "through our hands". He farms with grain, cattle, and more recently launched his own abattoir and range of delis and restaurants. Nick doesn't believe in the middle man—until you chew your steak, he'll be with you."

Of all the traits the *megaboere* share, their entrepreneurial genius is what sets them apart.

"They constantly take notes, build things, and drive people crazy. These farmers don't believe in being halfway scared, you jump or you don't. They know when to take risks, and when to prepare for the worst. They have hawk eyes when it comes to exchange rates and planning accordingly, and they never settle down." •

Watch Booyens' complete talk on our YouTube channel [here](#).



AUTHORITY

in the workplace

talk by Kotie Pieters
summary by Esté Beerwinkel

Kotie Pieters from the Koue Bokkeveld Opleidingsentrum says authority at work translates to more than giving orders and getting your way. She shares vital tips in establishing healthy, sustainable relationships and authority at work.

“WHAT is authority?” Pieters quotes the *Immergroen Ouerskap’s* definition of authority as “having the power and right to lead, influence, control, give tasks, and having the expectation of obedience.

Pieterse says when one speaks to others with respect—despite their rank—they become more approachable and their workforce becomes more willing to execute and excel at tasks.

“While your position of authority gives you the right to give workers assignments, how you instruct them determines the quality of work and attitude you’ll get from workers. Approachable body language and a calm tone of voice empowers workers, and keeps the line of communication open.”

Pieters says position doesn’t necessarily guarantee authority, and it can be lost when abused.

“Having authority is a great responsibility. You should lead and empower your staff.” Pieters indicates some of the pitfalls:

- using defamatory, destructive, and abusive language,
- not listening when people speak eg. prioritising phone calls over conversations,
- tone of voice, speaking in a rude, manipulative or nagging manner,
- dishonesty—always keep your promises and you keep your workers’ trust,
- stress, treat the people with respect even when stressed
- abuse of power—acting lawless, as if rules don’t apply to you
- body language eg. being standoffish, unapproachable

- But, Pieters says, authority can be strengthened. She suggests these tips:
- be humble—no one is perfect, everyone makes mistakes,
 - accountability—own up to the mistakes you make, and don’t shift the blame,
 - set boundaries—don’t make things personal, or mix personal with professional,
 - lead by example, in other words do as I do,
 - create joy—build an emotionally safe workplace, you influence people’s moods, their happiness at work is your responsibility
 - inspire greatness and goals in your workforce
 - be straightforward, don’t talk in riddles and never expect workers to read between the lines, also don’t assume that they know what to do.” •

Watch Pieters’ comprehensive talk on our YouTube channel [here](#).



SOUTH AFRICA:

Seize the #Ramamoment

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talk by Daniel Silke
summary by Esté Beerwinkel

South Africa is undergoing substantial domestic political, and economic change. But there are major global factors that are impacting this and other emerging markets worldwide—higher interest rates in the United States, a stronger US dollar, and higher oil prices. Political analyst and futurist Daniel Silke, sheds light on these events and what it will mean for South African agriculture.

"GLOBAL events impact emerging markets across the world, and South Africa will certainly be battered by these factors. Despite fresh leadership, South Africa won't experience improvement in gross domestic product growth or unemployment until systems and personalities change, and policy gets fleshed out to a much greater degree," Silke says.

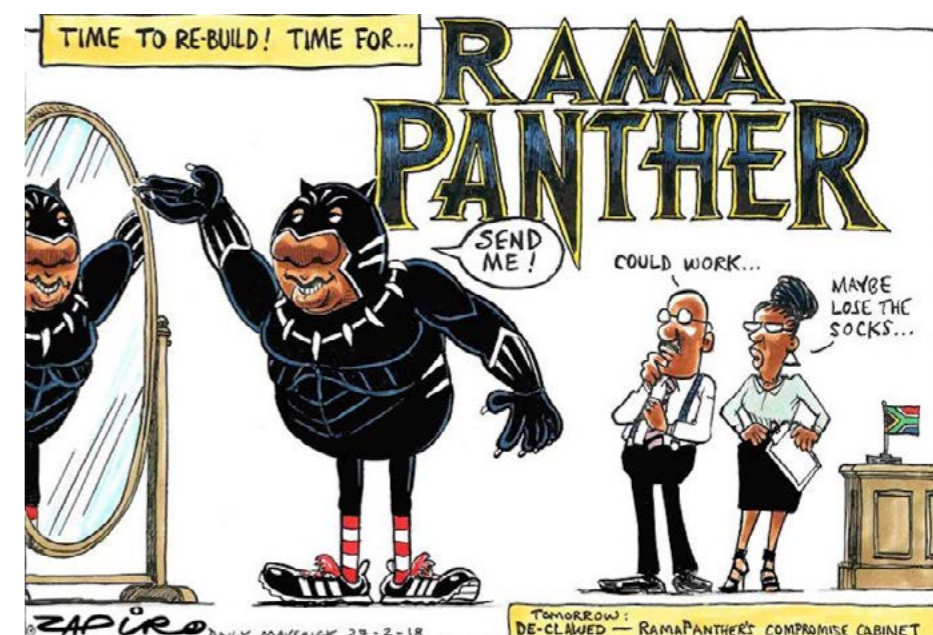
The South African economy remains sluggish, its growth prospects are almost stagnant, and the country has a few hurdles to cross before meaningful change occurs, Silke maintains.

"For the next year or so we shouldn't expect any meaning improvements in the South African economy. We're gearing towards an election, an important election for President Ramaphosa, and the land expropriation debate drained many citizens. But I remain optimistic, the potential and possibility for our economy to improve is there."

Silke continues by saying although the approach toward the land debate is becoming more nuanced and balanced, South Africans should still practise caution.

"We're on the cusp of seeing improvements and progress, but we should keep our seatbelts fastened until after the 2019 election."

According to Silke, agriculture remains a contentious issue throughout land expropriation saga.



“South Africans should keep their seatbelts fastened until after the 2019 election.”

“Agriculture is at the centre of the land debate within South Africa—not just from a South African point of view, but global population increases affects food food security. Greater Africa and South-east Asia’s populaces are booming, and it’s predicted that agricultural output has to increase twofold by 2050. There is pressure on land, farming techniques, labour, and on society to accomplish this rollout of productivity. Without agriculture people won’t eat.”

Silke says South African agriculture faces both performance and political pressure, but citizens should look at the bigger picture.

“Agriculture isn’t only necessary for food security, but is a major player in the political arena. It’s not just about a farmer and his land, but links to a sector that contributes a large percentage of the country’s gross domestic product—and the pressure on farmers to perform will only increase.”

To ease the pressure, Silke reckons agriculture must be allowed to perform.

“The operating environment for agriculture has to be conducive for production to increase and greater employment opportunities to be presented. Farmers and those without access to land should feel they participate and add to the production process. There is tremendous opportunity in the sector, but we have to look at the bigger picture all the time to tick all of the boxes to make sure we’re in the right place first.

“If we tackle the land issue in a responsible fashion, and the parliamentary committee looking into a land redistribution or expropriation deals with it in

a more nuanced manner following good research—which is available to South Africans—then I think we can really leverage the land issue to enhance food security and general security of tenure in South Africa. The aim should be to make all South Africans feel more secure.”

Silke says how South Africa handles land redistribution will ultimately determine domestic and overseas investment buy-in.

“It’s better to deal with the issue in a responsible way, than push it under the carpet or, with it inefficiently as it has been done. Government understands the importance of agriculture to the domestic GDP, and it understands that it will not get investment buy-in outside or domestic unless it can secure a decent regulatory regime for the agricultural industry itself.”

For Silke optimism is still the way forward. He claims that at last the matter is being handled.

“While I remain optimistic of future, the process has to be watched every step of the way. I don’t think South Africans can relax until the process unfolds further—and that’s good for all of us, we should police everything all the time.

“Fundamentally, given the big macro pictures available, the need for food security, growth, and security, the agricultural sector is in good shape. It has a solid foundation, and if it can overcome this broad political regulatory side that’s about to emerge, I think everyone can benefit. •

Watch Silke summarise his presentation on our YouTube channel [here](#).



groundwater use as the drought holds centre stage

talk by Roger Parsons
summary by Munyaradzi Makoni



According to hydrogeologist Roger Parsons, boreholes are an investment. He shares insight on sustainable borehole water-use during the drought.

drought

has brought Roger Parsons' underground work to the surface.

Recently, the hydrogeologist from Pringle Bay, has been shuttling countryside from one community to another advising them on sustainable groundwater use.

Poor rainfall over the past three and half years has contributed to the current critical water shortages in South Africa, particularly in the Western Cape, he says.

The agricultural industry and urban environment suffers under severe water shortages.

These shortages have a devastating impact on the economy and the poor.

"Day Zero was a useful tool until it became a political football," he tells the symposium crowd, "and while Day Zero is off the table for now, nothing has changed.

"Our dams are empty, we haven't had significant rainfall and we don't know how much rain will fall in the next four months."

Cape Town's establishment relied on the springs flowing from Table Mountain. But expansion into the drier parts of the country was groundwater-driven—hence the many farm names ending in "fountain".

Parsons notes that as populations grew, so did the demand for water. Dams sprouted in order to store water for drier times and have since become the preferred water source in South Africa.

"But now our dams are failing due to an ever-increasing demand and prolonged below-average rainfall.

"The poor state of dams across the Western Cape province, has forced people to hunt for alternative water supplies—thus the surge in groundwater popularity."

About 13% of all Western Cape municipalities' water comes from groundwater, this is similar to the national average. About 62 towns and villages rely on groundwater.

Parsons believes the mismanagement and sudden demand of groundwater puts it at risk. Aside from this,

he also claims there's a lack of skills in groundwater management.

He notes that while information about dams and their locations are plentiful, this isn't true for aquifers.

"The mention of groundwater and boreholes invokes images of storkiewysers and water dowers but people forget that the agricultural sector has developed beyond that over the last century.

"Previous generations used to farm with horse-driven ploughs, now we use tractors and GPS-driven systems—groundwater use has also evolved and should be treated thus."

According to Parsons, farmers use a range of different technologies such as soil moisture probes and their cell phones to inform them when their irrigation systems need to be activated—but they don't apply the same technological approach to groundwater use.

His advice: use experts to make sure you get the most from your groundwater source.

"There are many charlatans out

there. Don't be impressed by smooth talking and pretty pictures. Get knowledgeable references on hydrogeologists, drillers, pump testers and equippers.

"Developing groundwater resources cost time and money, but it's an investment to support and sustain your business. Your borehole should be treated in the same manner you'd treat your tractor or car—in order for it to perform it needs to be well looked after."

He provides the following tips for sustainable groundwater use: a pump test to gauge your resource, robust wellhead protection, use a data logger to monitor happenings below the surface, and appropriate use and ongoing operation and management. And he emphasises, failure to register—and if required—licence your groundwater puts you at risk. •

Click [here](#) to watch Parsons' summary on our YouTube channel.

THE FUTURE OF water availability in the Western Cape

*talk by Aisha Petersen
summary by Munyaradzi Makoni*

Selling off animals, shrinking hectares farmed, disappearing jobs, and declining profit margins are only some problems brought on by the current water shortage. Western Cape Government's Aisha Petersen speculates on the province's future access to water.

PLANNING for a sustainable future is the biggest offer on the table, according to Petersen, director for sustainable resource management at the Western Cape Department of Agriculture.

South Africa's annual rainfall is 470 millimetres—80% of this pours down in five months. Being in a semi-arid region some 50% Western Cape areas receive between 50 to 100 millilitres rainfall—which is sparse.

"What makes the Western Cape unique, is that it receives most of its rain in winter when it's not needed," says Petersen. "The province gets 80% of rainfall in winter when there is only 25% demand, and in summer there is 10% of rainfall when there is a 75% demand."

"We need to store winter runoff in dams so it'll be available for summer irrigation," she says.

In the Western Cape, agriculture sustains a R530 billion economy which employs 2,4 million of the province's 6,4 million citizens. About 75% of this agricultural workforce is unskilled.

On May 28, 2014 dam levels were at 72%. On the same date in 2018 it stood at only 24%. Three years of below average rainfall have resulted in a loss of earnings, production, and jobs.

An analysis on the impact of water restrictions on production during 2017/18 shows an expected 37% decline in production—this translates to a loss of R4,96 billion and 50 000 jobs for the Western Cape agricultural industry.

According to Petersen, the value chain will be under severe pressure with reduced inputs from the rural areas that'll cause financial losses, including income tax, value-added tax, and large-scale job losses. The sector will lose a valuable market share in fruit exports, with the possibility of some farm operations left bankrupt.

The Western Cape water supply system has six major dams which are linked to each other and managed together. But trouble rears its head when there isn't enough irrigation water as the sector requires.

Water restrictions, a water conservation tool, vary between communities. It pegs the Breede Valley and most of the Western Cape at 60%, while other areas face restrictions of over 80%.

This past season, the Lower Olifants River Area (Clanwilliam, Klawer, Vredendal) only received 17,5% of their normal water allocation.

Petersen says they have allocated the most water to the Western Cape metro where the majority of people live—70% of water in the province is allocated for domestic use, while 30% is for agricultural use.

"While the domestic sector assumes the agricultural sector isn't doing enough to save water, they don't realise that agriculture's allocation is significantly lower than what they require," she says.

Even when the Theewaterskloof Dam is full, farmers are only allowed 30% access, Petersen adds.

"We're negotiating with the ministry to get water restrictions relaxed and review the system while dams recover to help farmers cope with losses.

"So far the province has spent R120 million to cushion farmers from the ravages of drought.

As climate change predictions point to drier seasons for farmers in the region, Petersen ended off by encouraging continued water-saving efforts, and urging users to establish forums for data collection and water-use monitoring for self-regulation and accountability. •

Watch Petersen summarise her presentation on our YouTube channel [here](#).

PRACTICAL

farming advice for drought management—the effect on fruit quality

*talk by Willem Burger and DeKock Hamman
summary by Esté Beerwinkel*

According to producer Willem Burger from Alhambra in Ceres, the farmers who had less water this past season performed better than those with sufficient water supply—he believes this is due to superior water saving techniques. Burger and De Kock Hamman from Ceres Fruit Growers shared practical advice for retaining good fruit quality during a drought.

“GET RID of static spray, and start making your irrigation plans early-on.” This was the first piece of drought management advice given to symposium-goers by Burger.

Burger believes by updating the irrigation designs at Alhambra, they used up to 40% less water than normally.

“We were proactive, followed four steps, and received good production results: reduce the fruit on the trees, ensure irrigation system is appropriate and adequate, mulch, and only irrigate at night to limit evaporation.”

According to Burger everyone should believe the hype surrounding mulching. “Our Golden Delicious orchards need 7000m³/ha, but this past season we only had 4000m³/ha and we not only survived, but produce good quality fruit. I believe this is because we removed 5% of our orchards, only started irrigating in November and only irrigated at night, and covered 25% of the remaining orchards with mulch. Compliance is also key—everyone needs to buy in, and partake in the water-saving plan.”

Hamman seconds Burger’s tips, and adds that growers and workers alike need to get their heads in the game.



“A drought-year always requires a mind-shift—you’ll have to be resourceful and up to the challenge of still producing good quality fruit. We encourage growers to remove trees if they don’t have enough water—if you only have 30% of your usual allocation don’t waste it trying to cover the same area you used to cover with much more water.”

Hamman says growers should be careful of planting ahead. “New plantings should only happen if there is enough water available. Never plant ahead hoping that future rainfall will provide water—that rain may never come. If you can’t provide the tree 70% of the water it needs, remove it. This also depends on your soil-type. Clay soils can get away with 60% of needed water due to the soil’s ability to retain water. But shallow sandy soils require at least 70% of the water needed.”

According to Hamman the drought affected apples more so than pears.

“Pears in our region had minor, to no issues this past season. Size was the biggest issue, but it was only one or two counts smaller. This can’t necessarily be prescribed to the drought, as we had quite a cool early summer, and a very hot late summer. Many producers also overload the trees.”

Hamman continues by encouraging producers to thin orchards early. He says 70% of water can produce up to 50 tonnes/ha.

“Don’t keep fruit on trees if you don’t have sufficient water. The fruit will still require water, pest control, fertiliser, orchard sanitation, and harvesting—harvesting of small fruit is expensive, and not worth the trouble.”

Hamman says accurate crop estimating is to your advantage. “Empty crates don’t make money. Seeing

fruit doesn’t always mean you’ll get the volume or mass. Keeping small fruit on the tree, hoping it will grow will be to your detriment.”

Check your soil’s calcium level, Hamman encourages, failing to do so could leave you with lenticel breakdown and bitter pit problems. He also advises producers farming in brackish conditions to seek expert advice during the drought.

“Remember, big fruit are prone to bitter pit, and be careful not to over thin these varieties: Early Red One, Mahana Red or Braeburn, Kanzi, Jazz, and Golden Delicious.

“Hamman says knowing when to give trees water will save you a world of trouble. “Give trees enough water in the first 40 days until the cell division phase—you can give less water in the middle, but in the last five weeks before harvesting you have to give water again. Failing to do this can cause water stress, resulting in stem and calyx end cracks. This will leave with small unmarketable fruit the juicing factories won’t even want.”

Hamman concludes by reminding growers that every cloud has a silver lining. He lists the advantages of a drought as follows:

- Very good fruit colour,
- Fewer fungal diseases,
- Very low risk for internal browning,
- Less vigorous growth,
- It teaches growers to manage water efficiently,
- Non-profitable orchards get removed, and
- Overall good fruit quality. •

Click [here](#) to watch Burger’s summary on our YouTube channel. And [here](#) for Hamman’s summary.



MANAGING

apple replant disease without fumigants

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*talk by Prof Adele McLeod
summary by Munyaradzi Makoni*

Replanting apple orchards is inevitable for most growers—and along with it apple replant disease. Prof Adele McLeod discusses the topic.

much research has been done to combat and avoid this disease caused by a complex range of soil organisms including fungi, lesion nematodes and oomycetes.

Apple replant disease occurs when replanting is done on a site previously planted to apple and inhabited by the above-mentioned soil organisms.

“It is important that all interventions you make must target all three of the disease causing groups; if you only target one group you are unlikely to manage replant disease effectively,” McLeod says. “This is the challenge in finding a universal solution for apple replant disease.”

Historically, fumigation has been the “remedy” of choice, because you don’t have to use specific management techniques or have knowledge of a specific organism, she says.

But alternative control methods gain

traction as growers are “losing” fumigants due to new pesticide restrictions.

According to McLeod growers can no longer use methyl bromide. And the list of banned and restricted fumigants and chemicals continues to grow.

Research on one alternative—the application of Brassica (a genus of plants in the mustard family) seed meal amendments—for the control of apple replant disease was started in 2001 in the United States.

McLeod says a study in 2005 revealed seed meal from different Brassica spp. possess varying potential to suppress plant pests, but when utilised independently (single species) the seed meal always failed to provide a fumigant level of replant disease control.

In 2007, each of three seed meals—brown mustard, white mustard and canola—was experimentally tested against each pathogen group causing replant disease. Based on these findings, a seed

meal formulation was developed and deployed for 2009/10 in field trials.

The following was found:

- Jonagold/G11 root infestation by *Pratylenchus penetrans* (nematodes) and infection by *Pythium* spp. (oomycetes/algae) were elevated in fumigated soil, but were suppressed in seed meal amended soils
- Compared to using no treatment and treatment using 1,3-dichloropropene/chloropicrin fumigation (Telone C17), Gala/M9 planted in seed meal amended soils produced higher yields
- Seed meal induced suppression of *Rhizoctonia solani* AG-5 apple root infection
- Disease control was obtained irrespective of the degree of seed meal glucosinolate content (ultimately produces the toxic gas isothiocyanates)
- When analysing the bacterial community in seed meal treated rhizosphere

soil samples—the narrow region of soil that is directly influenced by root secretions—it showed that seed meals cause a large disturbance and change in resident soil organism populations.

- Brassicaceae seed meals can provide fumigant levels of soil borne disease control.
- The effectiveness of Brassicaceae seed meal is dependent on the specific mixture of seed meal used.

Anaerobic soil disinfestation is another non-fumigant approach showing promise for managing apple replant disease. ASD consist of decomposition of a large volume of a labile carbon source (e.g. grass clippings or molasses) in the soil, which creates anaerobic conditions and elevate beneficial microbes, which can control some soil pathogens. The usefulness of ASD is dependent upon carbon input.

According to McLeod the high cost of seed meals is a limiting factor in the wide-spread use of this replant disease management method, as it costs twice as much as fumigation. Furthermore, the mixture of seed meal types required for replant disease management is not available in South Africa. ASD also requires large organic quantities of 10 to 20 tonnes per hectare.

Active management of the soil microbiome—all the living entities in the soil—may yield more resilient and productive cropping systems than attained in response to fumigation, which indiscriminately kills good and harmful organisms. However, with fumigation the soil microbiome (good and harmful) usually recovers within 1 to 2 years. The resilience of ASD and seed meals lies therein that it can prevent the harmful microbes from re-infesting the soil. This resistance to pathogen re-infestation of soils is associated with large changes in the spectrum of organisms in the soil and elevated abundance of specific microbial groups. •



Above: Trees planted in a site with replant disease.

Right: Healthy trees.

Photo credit: Mark Mazzola, USDA ARS



NEMATODE

occurrence in the pome industries, effects and treatment

talk by Lené van der Walt
summary by Munyaradzi Makoni

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THE stylet of a nematode works like an injection needle. These microscopic creatures are long, thin, and have hollow tube-like stylets with which they “inject” enzymes into plant roots, while also removing plant sap.

Lené van der Walt, a researcher at Nemlab, says temperature is the determining factor for nematode survival. Most nematodes on fruit require 25 to 28°C to reproduce, and their populations are highest during summer. Nematodes prefer and multiply faster in sandy soils as its temperature is higher due to bigger pores.

But not all nematodes favour sandy soils; ring nematodes prefer a stone or shale fraction. Each type of nematode has specific plant hosts it prefers, and a good plant host will show a rapid increase in nematode numbers. Apple trees mostly host lesion nematodes, with stubby root and dagger nematodes also playing a role.

According to Van der Walt, pome production suffers when nematodes move in—apple production goes down with 8%, while pear production shows a 5% reduction.

The sources of contamination often include plant material, water and soil.

The root lesion nematode lives within the roots (endo-parasitic), thus a root and soil analysis is required when testing for nematodes. Lesion nematodes causes necrotic lesions (or dead

plant tissue), which can get infected by secondary pathogens. Such attacks result in a gradual decrease in production as time goes by. Affected crops struggle to maintain fruit size, trees have low potassium uptake, and this is clear in differences between soil and leaf analyses.

Van der Walt says there is a need for increased awareness about nematode occurrence in the pome fruit industry as the problem is more serious than initially thought. While pear rootstocks appear more tolerant to nematodes, stubby root nematodes in sandy soils can induce stunted trees.

“Nematode control is all about prevention,” she says and suggests the following tips:

- First send samples for nematode analysis (roots and soil).
- Bring nematode numbers down to the minimum before planting. Young roots need a good head start.
- Select the right rootstock and use certified planting material only.
- Remove as many old roots from the soil as possible.
- Control nematodes in the two years before replanting.

Van der Walt states that farmers can fumigate, use nematocides, and manage biology and root health to control nematodes.

She mentioned that the nematocides cadusafos and furfural are currently registered on pome fruit and adds that DiTera is in the process of being registered on pome fruit and some other crops. She also emphasises that it is very important to apply chemical products correctly.

“Always determine the level of infestation first. A sample taken before removing of the old orchard will show how many treatments are required. The first treatment will be at six weeks after planting and the second treatment two months later.”

Although nematocides are relatively easy to apply and effective, it has a downside. Not only are they expensive, they aren’t sustainable. The incorrect use of nematocides lead to accelerated microbial degradation and disturb the ecological balance in the soil.

Much is still to be done in terms of research on tree crops and alternative treatment options, Van der Walt says. So far completed trials delivered varying results.

While some nematodes are considered pests, beneficial nematodes- entomopathogenic or insecticidal nematodes-exist. “These nematodes are lethal pathogens of insects and can be effective biological control agents,” she says. •

LAND REFORM

agricultural development + in South Africa: Keeping a cool head

talk by Prof Ben Cousins
summary by Dane McDonald

The call for land expropriation has its origin in the crisis of the post-apartheid settlement in South Africa, according to Prof Ben Cousins, a land reform expert.

PROF Ben Cousins' own views sit approximately at the centre of two extreme views of the current South African 'land expropriation without compensation' debate.

Cousins is a researcher at the Institute for Poverty, Land, and Agrarian Studies (PLAAS) which is based at the University of the Western Cape - he holds a DST/NRF Research Chair.

The first view, according to Cousins, is that South Africa has a history of land theft and land dispossession. In his view this is broadly correct, but leads to the position that all land must be expropriated without compensation. And (in one version of the argument) should be held by the state - the political view of the Economic Freedom Fighters (EFF). In this view land is seen as a symbol both of the past and of a different kind of future.

At the other end of the spectrum is a view most often expressed by relatively privileged white South Africans. It is a view which sees attacks on property rights as 'the beginning of the end' or 'the road to ruin'. According to Cousins it is a view that generates extreme, 'very emotional' reactions. In this view land is also seen as a symbol, albeit one of other things - efficiency, productivity, and the modern economy.

Cousins argues that neither of these views, particularly in their extreme forms, are very helpful.

In contrast to the former two views, Cousins' 'middle ground' view begins with asking a few questions and requires a pause for thought. It asks questions like "where does this call for expropriation without com-



pensation come from?" "What is it a symptom of?" "What is the underlying condition which gives rise to this potentially destabilising call?"

The post-apartheid crisis in SA

South Africa is the most unequal country on earth with a 'Gini coefficient' of 0.63 (2015 data) for income. This coefficient is the most common measure of inequality for countries. Of more concern, according to Cousins, is the fact that in terms of wealth-assets, the Gini is currently sitting at around 0.9, which is extraordinarily high—for context, a value of 1 means absolute inequality.

This level of inequality is not sustainable, says Cousins, with the diagnosis that it is out of this unsustainable situation that the emotive land debate is flaring.

Dangers and opportunities

One of the dangers is that an emotional form of politics—a potentially authoritarian form of populism—commands the agenda and adds fuel to the fire. According to Cousins this could happen at the expense of cool rational debate about the 'very real challenges facing us'. Along with this danger Cousins senses a different agenda lurking 'beneath the surface' of populism, the agenda of elite or state capture, as experienced under the Zuma presidency.

From attending various key ANC events like the recent Land Summit, Cousins has observed that there are many cadres in the ruling party who are still set on a programme of state capture.

At the same time, Cousins sees many opportunities, not least the change in political leadership. Also, the issue of 'land' is not the answer to all of South Africa's problems. "It is not a silver bullet for South Africa's wider problems of poverty and unemployment," he says, adding that there has to be a change in which society (and particularly the economy) is structured.

Yet, land and agriculture is 'relatively' central to this wider economic debate. Cousins warns that land 'as a symbol' of wider problems needs to be acknowledged, because it is not something that is going to go away. "If we don't resolve it, if we don't change patterns of land ownership - it is going to explode in our face," he says.

The opportunity to engage in an effective rural land reform programme needs to be seized, according to Cousins, adding that it will need to be linked to 'agrarian reform' - changing the structure of agriculture.

'Three provocations'

Considering the issues of deep structural poverty and inequality, Cousins offers three provocations to the deciduous fruit industry, which will require a 'cool head' to consider and respond to. They deal broadly with property rights, title deeds, and small-scale agriculture.

Firstly, property rights are a relatively recent invention. In SA the dominant version is private property. According to Cousins, property rights are not absolute, they are always socially regulated to some degree. For example, society has interests in the environment/ecology/resources. And in terms of development planning, private property holders have to submit to the needs of developmental investments in the wider interest - for example, infrastructure and services.

Secondly, title deeds which give legal expression to private property in South Africa are built upon the foundations of Roman-Dutch law. The legally binding version of the title deed which South Africa subscribes to means something very specific and is not appropriate for a large sector of society. It is costly, cumbersome, and does not capture concepts of shared property in social land tenure systems. It is estimated that 60% of South Africans hold land and housing outside the formal property system.

Thirdly, small-scale farming needs to be recognised as a crucial source of livelihood with its po-

tential to alleviate poverty and structural inequality. Cousins suggests that the SA agriculture dispense with the inappropriate idea that a few black commercial farmers are going to solve the challenges. While there are 5000 black commercial farmers in SA, there are at least 250 000 market-oriented small scale farmers who could be the key beneficiaries of an appropriately focused rural land reform programme.

What can you do?

To Cousins it has become apparent that there are large landowners who are willing to donate land for free, for land reform purposes. These offers are coming from across the spectrum, from all the provinces. At the moment, however, there is no law for these types of donations to take place. The present land debate may offer opportunities to develop such a law.

Cousins encourages growers to think beyond the 'black commercial farmer', and rather focus on market orientated small-holder farmers, which could have a greater socioeconomic impact. It is important to be aware of the fact that these farming systems operate in different ways and are embedded in different livelihood systems.

In terms of informal markets, large commercial producers can withdraw (mostly 3rd grade produce) from these markets where they compete directly with smallholder farmers. Here the government could play a key role in providing venues and enabling regulatory environments for farmer's markets.

In conclusion, Cousins says there are many uncertainties and risks at the moment.

"There are real dangers, but there are also possibilities of renewal...which is ultimately the only thing that is going to provide us with a sustainable future. And all of us have major contributions to make. So, let's stop panicking, keep a cool head, and find ways to make this thing work - let's all come to the party." •

STRATEGIC CHANGES

in the crop protection environment and its impact on the deciduous fruit grower

Biological pest controls are here to stay, while the prevailing 'environmental storm' is not going anywhere, says Intelichem's Rudolph Geldenhuys.

BIOLOGICALS will become increasingly important as part of an integrated approach, says Geldenhuys.

Biological pest control or 'biocontrol' is a method of controlling pests such as insects, mites, weeds and plant diseases using other organisms - it relies on predation, parasitism, herbivory, or other natural mechanisms, but typically also involves an active human management role.

"It is predicted that biologicals will grow at a compound annual growth rate of about 14% in the next few years till 2020, compared to conventional pesticides, which is estimated to grow at only 5% - currently biologicals have also increased from 2% of current market to approximately 8% of the market," Geldenhuys says.

The growth in the biological control market is happening on the backdrop of two major trends in the global Agchem industry: China's increasingly strict environmental compliance requirements and

the routine banning of mainstay chemical pesticides by the European Union (EU).

The EU has implemented a 'near' total ban on the neonicotinoids, currently the world's biggest insecticide group. Switzerland is to vote on a complete synthetic pesticide ban within the next three years and France has indicated an intention to phase out synthetic pesticides in five years.

When China 'chokes'...

In terms of China; when the supply of pesticides from China chokes, the world coughs. China leads the world in generic pesticide production and currently produces 90% of the world's active ingredients. So, any disturbance in supply from China affects the 'supply and demand equation' globally.

According to Geldenhuys China has established new pesticide regulations and an environmental risk assessment law which 'changed the rules of the game'.



“There has been massive factory closures as China cracks down on polluters. And the main aspect was focusing on pollution and local regulations. It is expected that more than 40% of the small and medium factories will be phased out in the next five years and this is part of a five year plan, implemented in 2015,” says Geldenhuys.

The chemical industry has seen trends of between 10-90% price increases across a wide range of products due to these disturbances.

So, despite the uptick in the biological pest control market at present, Geldenhuys says they are there to complement the chemistry portfolio—which is facing serious challenges.

Challenges and strategies

Geldenhuys says Mergers & Acquisitions are reshaping the industry. Of the ‘big 6’ (BASF, Bayer, Monsanto, Dow, Du Pont, Syngenta) dominating in 2010 there will only be a ‘big 4’ left (BASF, Bayer, Dow-Du Pont, and ChemChina).

With China’s crack-down on polluters, prices are expected to increase by 20–30% in the foreseeable future, lasting for the next 18–24 months, mainly due to prevailing supply challenges.

“And we going to see a delayed lagging action only from the third to the fourth quarter this year. The reason being that there is still a lot of stock. We’ve had a drought situation so once the current stock is depleted we’re going to see the effect of these price increases coming through,” says Geldenhuys.

Considering the prevailing ‘agribusiness’ environment growers should cultivate a relationship with a ‘trusted business advisor’. According to Geldenhuys the grower will need the extreme specialist, who is going to be able to work closely with him/her to interpret multiple layers of data and provide information on potential opportunities and pitfalls.



Geldenhuys also encourages growers to embrace ‘smart farming and big data’ which he believes is going to have a major effect on the deciduous fruit market - predictive data analysis with precision applications and layering of data to optimise output “is going to have a major positive effect on agriculture”.

In conclusion, Geldenhuys says leadership among growers will be key: “We have to execute strong leadership by doing the right things, think differently, do something brave and accept that business is not as usual - we will however have to react fast to capitalise on the opportunities created by a dynamic changing environment”. •

OVERCOMING phytosanitary obstacles

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talk by Hugh Campbell
summary by Dane McDonald

STONE fruit growers were lauded at the 2018 Hortgro Science Symposium, as the industry maintained its zero interceptions status of false codling moth by the European Union (EU) for the 2017/18 season.

To an outsider this might sound insignificant, but this is a big deal if one considers that the R270m Taiwanese market was shut down to South African growers in the same year because of a single 'diapausing' codling moth larvae.

The European Union is a key market for South African stone fruit growers as 71% of peach and nectarine exports go to the UK and Europe. so even through it was monitoring the process it was no surprise that the industry was still rattled by the announcement that false codling moth (FCM) was a 'regulated pest' for peaches and nectarines from January 2018. During and prior to this period much deliberation and negotiation was being carried out by Hortgro market access manager Lindi Benić and her team—behind the scenes.

Hortgro Science General Manager Hugh Campbell explains that by interacting closely with the Department of Agriculture Forestry and Fisheries (DAFF) Benić and her team play a key role in the space between the South African National Plant Protection Organisation (NPPO) and the NPPOs of importing countries, in this case the European Union.

Following these engagements and to ensure the EU markets remains open to SA growers it was decided that the stone fruit industry would undertake the option: "treatment to achieve consignment freedom", to meet the EU market's zero tolerance requirement for FCM.

Other products that were impacted by the change of status of FCM are citrus (excluding lemon and limes), pomegranates and peppers.

According to Campbell a 'Systems Approach' based on International Plant Protection Convention's (IPPC) ISPM14 guideline was devised. It comprises four critical control points which are logged on the "Phytclean" platform:

- Orchard registration is needed.
- Pre-harvest fruit damage assessment based on Dr Ken Pringle's monitoring system (25 trees per 2Ha, 10 fruit per tree, i.e. 250 fruit to be inspected). Any positive identification of FCM disqualifies the orchard.
- The next critical point is packhouse delivery where 600 fruit are sampled per day, again, should there be any interception - the orchard is taken out.
- The last critical end point inspection is carried out by the Perishable Exports Control Board (PPCB). Again, any positive identification of FCM kicks out the orchard.

Campbell said the foundation of the Systems Approach was a good 'monitoring system', which could not be emphasized enough. "Integrated Pest Management and monitoring is the basis of what we're talking about. So it's about making sure that we have the correct practices in place. And monitoring, monitoring, monitoring is the basis," he said.

According to Campbell pest surveys were becoming increasingly important in the effort to demonstrate that a particular pest was not present. The example of *Bacterocera dorsalis* (Oriental fruit fly) is instructive whereby the deciduous fruit industry has 'dynamic' map indicating fruit fly absence,

presence, and extent of presence. South Africa's NPPO uses the map as a basis to report internationally on the status.

Recently the United States Department of Agriculture (USDA) stopped all exports from the Grabouw region due to an Oriental fruit fly incursion. In May they reverted back to the industry saying that the export of apples and pears to the EU would be opened, but under the provision that 'cold sterilisation' regimes be applied.

Campbell said the requirement of 'cold steri' regimes raises further challenges to industry. In the case of Oriental fruit fly, the USDA's requirement of 22 days at -0.5°C may not be an appropriate regime. "We're embarking on trials to demonstrate that Oriental fruit fly is less cold tolerant than Medfly...in other words it dies quicker - therefore the Medfly regime of 14 days at 1.11°C or 18 days at 2.22°C is adequate", said Campbell, adding that this was the kind of work required to keep markets open.

Campbell said that in terms of market access and its related phytosanitary matters everything was based on science. "All the communications and all the validation is based on peer-reviewed published articles. So, from a SA context we need science capacity. Without science capacity we will not be able to do this," he said.

Industry experts like Lindi Benić and Dr Ken Pringle and their teams were integral to the process, while government support and capacity was a priority. "The relationship is always between governments, so we need government capacity - this is absolutely critical," said Campbell.

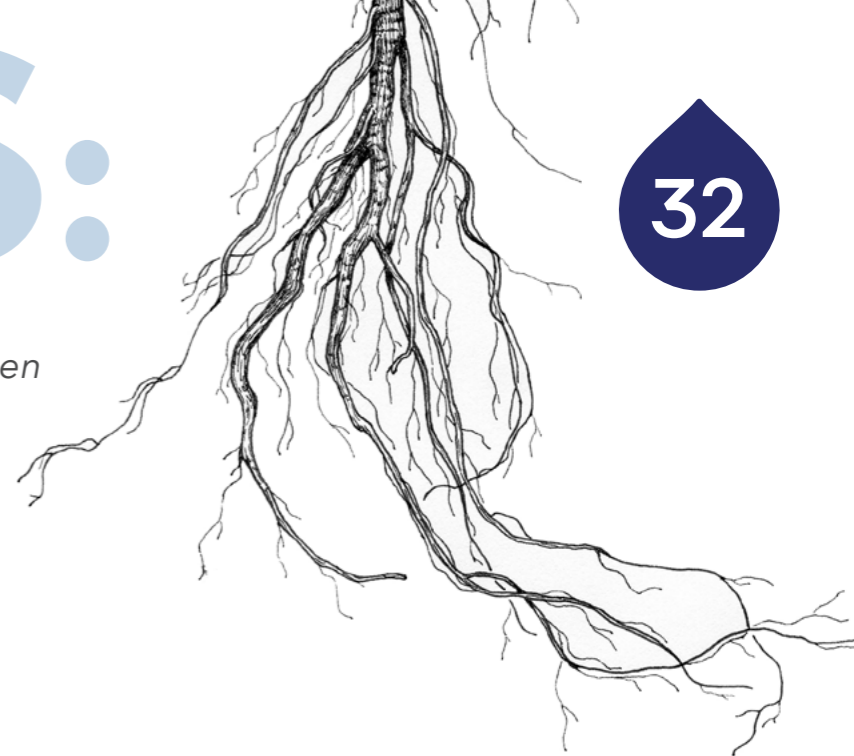
Finally, it is much cheaper to keep a pest out than to allow it in. •

ROOTSTOCKS:

when the easy choice isn't the best choice

talk by Frederik Voigt and Dr Piet Stassen
summary by Dane McDonald

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Despite being the 'industry standard' stone fruit rootstocks for several decades, Marianna and Kakamas are now being outperformed by many several other rootstocks when certain limitations exist.

marianna

and Kakamas rootstocks established itself as "easy to propagate and adapted to local climate conditions, says Frederik Voigt (Sapo Trust) and Dr Piet Stassen—but are they still relevant to our industry and our soil conditions?

The simple answer is 'not under all circumstances'.

Over the past 10-20 years research has shown that there are limitations to these rootstocks - Marianna and Kakamas are known to buckle under "certain abiotic stresses and plant-parasitic nematodes".

Stassen's rootstock trials indicate that Marianna and Kakamas are being left in the dust by higher performing new generation rootstocks adapted for certain soil conditions.

Rootstock trials

- For 'African Delight' on sandy, calcareous soil with high numbers of ring nematodes the average fruit weight for the Marianna rootstock was significantly lower than for the GF 677 (R), Cadaman, and Atlas rootstocks.
- For 'Laetitia' on high potential soil with moderate to high numbers of ring nematodes, Marian-

na was significantly outperformed by four competing rootstocks when measuring average fruit weight, with Atlas rootstock performing the best in terms of fruit size.

- For 'Alpine' on 90.6% well drained sandy soil in a northern fruit region (low chill area), Kakamas seedlings were significantly outperformed by Flordaguard and Atlas in terms of average fruit weight and again significantly outperformed in terms of cumulative yield over 5 harvests by the same rootstocks, but this time also beaten by the Guardian rootstock.
- For 'Alpine' on medium potential, calcareous soil with high ring nematodes, Kakamas seedlings were significantly outperformed on all metrics (average fruit weight and cumulative yield over 5 harvests) by the Atlas, Cadaman, Garnem, and GF 677 rootstocks.

It is apparent that Marianna and Kakamas are risky for environments with sandy and/or stony soils having low water and nutrient holding capacity, says Voigt, adding that the effects are worsened in the presence of high numbers of plant-parasitic nematodes and stress conditions.

Despite the obvious advantages of clonal rootstocks, their implementation at a larger scale by the South African deciduous fruit industry is being

hampered by the availability of rootstocks.

These included the 'variability of demand', 'orders in advance vs predictable availability', 'high maintenance cost of rootstock mother blocks', 'poor rooting ability and profitability' of clonal rootstocks', and phytosanitary problems.

To address shortages Voigt encouraged growers to do thorough medium to long term 'tree planting planning' to inform nurseries soon enough with orders and specifications.

Voigt has recommended the development of laboratory facilities for the production of in vitro plants to improve availability and a cost-effective price.

In a further effort to improve supply the South African Stone fruit Producers Association (SASPA) has initiated a project to expand and maintain 'foundation blocks', to reduce the risk of pathogens and improve production quality and quantity.

Yet, despite these developments, Marianna and Kakamas will always have a place in the South African grower's palette where certain soil conditions are present and due to its easy propagation properties and cheaper tree price. •

Click [here](#) to watch Voigt's summary on our YouTube channel.

RESULTS OF

shade net studies in Washington State

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*talk by Dr Giverson Mupambi
summary by Dane McDonald*

If you're a grower considering whether to install shade nets on your orchards, watch out, you could very well be pushed over the tipping point by Dr Giverson Mupambi's results.

DESPITE the reduction of sunburn incidence in fruit being a great motivator for putting up shade nets, Mupambi (a postdoctoral research associate at Washington State University) introduced the symposium crowd to a host of additional benefits including water savings - a big one under current drought conditions in the Western Cape.

"Below the ground, which might be of interest to local growers, you get high soil water content under the nets - it helps you keep the water in the soil," said Mupambi, adding that the reduction in radiant heating was lowering soil evapotranspiration from the orchard floor.

Hail and sunburn

Where hail damage was a problem, for example the Langkloof region in SA, shade nets form a protective barrier over the fruit. Mupambi's trials showed a reduction in the amount of

fruit damage from 80% in the control to 3% under drape nets, and 1% in exclusion nets. Hail nets could also reduce physical damage in young trees which can increase phytosanitary problems like 'fire blight' following hail events.

Sunburn was curbed in two ways through the application of shade nets, according to Mupambi. Firstly, the amount of solar radiation reaching the fruit surface is reduced resulting in lower fruit surface temperature from a reduction in radiant heating.

Secondly, the intensity of the light reaching the fruit surface is reduced, where high intensity is associated with the occurrence of sunburn in apple fruit.

Values for reduction in sunburn incidence from previous studies in Washington State ranged between 14% to 43% in 'Granny Smith' and 'Honeycrisp' respectively. Mupambi said these were values that growers should use when doing a cost benefit analysis considering the huge investment in terms of cost of shade netting.

"Additionally, under shade netting, there is increase in the high grade class 1 and class 2 fruit together with a reduction fruit culls resulting in a better 'packout'," he said.

Orchard microclimate

The installation of shade nets introduces a host of changes to the orchard microclimate.

The biggest change that occurs under shade netting is the

reduction in light intensity. Mupambi advised growers to be aware of this when determining the shade percentage to be used.

“Know the amount of light at your location and by how much you want to reduce that...you also need to know which cultivar you’re growing...for bi-coloured cultivars you would want a lower shade percent to ensure proper colour development...for ‘Granny Smith’ you can use a higher shade percentage,” he said.

The light spectrum will also undergo changes under photosensitive shade nets. For example, under blue photosensitive shade net, the proportion of blue light transmitted is increased. Blue light is linked to leaf photosynthesis through the regulation of stomata, the grower could ultimately manipulate this to increase production. Additionally, the increased amount of diffuse and scattered light under nets could be another boon to growers, where scattering of light has been linked to higher productivity due to better penetration of the tree canopy.

Decreased soil temperature under nets could mean mitigation of heat stress which can limit whole plant function and decrease crop productivity.

Fruit quality

Mupambi’s trials on ‘Honeycrisp’ showed that average fruit size was significantly higher under nets than in the uncovered control block.

Under shade nets fruit showed a slight reduction in ‘soluble sugars’, while uncovered control trees had slightly better red colour coverage compared to netted trees.

Tree physiology

Mupambi found that under shade nets the tree’s light use efficiency was increased resulting in improved photosynthesis. . In his studies, photosynthesis was significantly higher under pearl and blue nets compared to the unnetted control.

The result of this improved physiology, according to Mupambi, was that growers could get healthier

trees which are less stressed.

Mupambi illustrated the fact by comparing third leaf trees under nets with unnetted controls, where the former had reached the target ‘top wire’, while the latter were struggling to reach that point - an indication that the trees were experiencing higher light stress.

Taking these results into account Mupambi said that some growers in the US were considering the possibility of establishing young trees under nets, so as to bring them into production sooner. He said SA fruit growers might want to consider this option.

In summary, Mupambi said that when considering the installation of shade nets “you’re not only thinking of the reduction in sunburn, but there are many other added benefits you stand to gain from using netting in your orchard”. •

Click [here](#) to watch Mupambi’s summary on our YouTube channel.



Photo: Stefano Musacchi.

Left: Hail damage on apples.

Right: Examples of sunburn.

Below: Orchard cover in multi-coloured netting.



PRELIMINARY

findings of semicommercial drape net trials

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*talk by Anton Müller
summary by Dane McDonald*

According to Kromco's Anton Müller, drape nets is what farmers need to make money.

THIS remark was almost lost on the crowd when Müller reported on his reported his preliminary findings on semi-commercial drape net trials.

Müller, a veteran manager and technical consultant with over 10 years' experience, said the trials were some of the most exciting studies he's ever been involved in.

Müller's trials are being carried out in the Elgin Grabouw Vyeboom Villiersdorp (EGVV) region. 'Drape nets' are loose nets draped over the orchard tree or a support structure with the purpose of protecting fruit products from hail or sunburn.

However, Müller's trials show that growers can expect more value than only protection from the latter factors.

His trial 'packouts' for both seasons of 'Granny Smith' apples showed that there was a reduction in class 2 fruit, but more importantly for Müller there was a reduction in class 3 fruit with a marked increase in class 1 from 50% on-tree fruit to 70%.

"Chemical products in the past showed some

negation of sunburn, but could only shift class 3 fruit to class 2 but not class three to class one," he said.

Müller said that both seasons showed a markedly higher percentage green fruit under the drape nets in comparison to the control trees (75% vs 55% of total on-tree fruit).

A slight reduction in fruit size was recorded under nets. Müller said the reasons for this was up for debate, and suggested that it could be the "psychology" around less "hand thinning" under the nets or otherwise a potential downregulating of photosynthesis.

The BIG one—sunburn

"There was a dramatic reduction in sunburn," according to Müller. This was clear from the graphs which showed the bars for the percentage of sunburnt fruit on the control trees towering over the bars indicating those of trees under drape nets.

In 2017 30.8% of the total fruit on trees without drape nets were sunburnt (Class 2+3), on the other hand only 8.5% of the fruit under drape nets were sunburnt. In 2018 the comparison was similar with 27% (control) and only 5% sunburnt under drape nets.

Growers can also expect a reduction in 'blush' (18% vs 4% average) and the potential to mitigate late season codling moth and stink bug damage.

Return on investment

Drape nets are a very good return on investment, according to Müller, who has seen the dramatic economic advantages of drape nets over uncovered controls. Using average values across his trial blocks he saw an advantage of around R1200 per ton of on-tree fruit.

In terms of returns per hectare, Müller advises that it depends on the orchard's tonnages, but he has recorded an average economic advantage of between R95 000 and R100 000 per hectare. In terms of the initial investment in a drape net system, Müller contrasted it with the alternative of a 'fixed net' structure.

The fixed net will cost the grower in the region of R300 000. In most cases this is a permanent structure which will experience the continuous effect of ultra violet (UV) radiation on the net (i.e. potential degradation over time).

In addition, Müller raised potential challenges related to 'dormancy under permanent netting', 'the effect on bee pollinators', 'impacts on chem-

ical thinning treatments’, and ‘the effect on growth vs yield, given that the majority of GRS orchards are on more vigorous rootstocks’.

Drape nets on the other hand cost in the region of R100 000 but comes at a management cost - it needs to be draped and fixed to the trees each year, as well as removed at harvest. In addition, the grower will need to carry out a ‘precision walk’ to make sure that there is no growth through the nets (to protect the netting).

Müller says the great thing about drape nets is that during ‘sensitive times’ the nets do not play any role - dormancy, bee pollination, chemical thinning, as it is only put up at the end of November. Spraying through the nets are not a problem, but even if it was, the ‘fusi’ risk is much lower after November than before.

In the meantime Müller’s trial studies continue, but these preliminary findings indicate that growers should seriously consider the horticultural and economic benefits of drape nets over existing or future GRS orchards. •

Click [here](#) to watch Müller’s summary on our YouTube channel.



Above: Orchard under drape netting.
Right: “The one that got out...”

Black drape netting vs White drape netting

APPLICATION

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of machine learning in surveying production

*talk by Prof Adriaan van Niekerk
summary by Anna Mouton*

Adriaan van Niekerk, director of the Centre for Geographical Analysis at Stellenbosch University, gave an introduction to machine learning. He used an example of yield predictions in the wine industry to show how machine learning and remote sensing could be applied to pome fruit production.

VAN NIEKERK started by contrasting machine learning with traditional statistics. Machine learning is a branch of computer science that uses algorithms to discover the relationships between variables. The goal is to build systems that learn from data. This differs from statistical modelling which tries to find mathematical equations that fit the data.

“My talk is about supervised learning, which is a subfield of machine learning,” said Van Niekerk. Supervised learning starts with humans creating a database of labelled samples. The labelled samples make up a training set—literally data that trains the machine-learning algorithm. The algorithm generates a model from the training set which it then applies to unlabelled samples. Initially the algorithm will not label all the samples correctly, but adjusting or adding labelled samples improves performance. The algorithm thereby learns from its mistakes and becomes more accurate with every iteration.

Van Niekerk demonstrated how this would work for an algorithm

that labelled fruit type according to shape and colour. If the only red, round fruit in the training set is an apple, the machine-learning algorithm will label all red, round fruit – including a tomato – as an apple. When the algorithm makes such a mistake, more training samples will help to refine classification accuracy. “Generally, the more data you feed into the machine-learning algorithm, the better the classification gets,” said Van Niekerk. “You want at least one sample per class per predictor variable.”

“Remote sensing,” explained Van Niekerk, “is collecting information from a distance.” Earth observation uses the observation and analysis of spectral characteristics to derive information about the surface of the Earth. Data sources range from satellites to drones. “We can use this type of information to monitor fruit crops,” added Van Niekerk.

“We now have a huge amount of remotely-sensed data,” said Van Niekerk, “and the nice thing about this data is that it’s becoming cheaper – or free – every year. But the problem is that it’s just too much data. We need something to help us make sense of all this data. And that’s where machine learning comes in.”

Examples of potential uses of machine learning applied to remote sensing data include: irrigation scheduling; harvest scheduling; crop condition monitoring; pest management; and crop yield estimation. Van Niekerk presented an example of crop yield estimation research conducted in the wine industry.

“Essentially we tried to model yield and phenology using FruitLook data as a series of covariants,” explained Van Niekerk. “We applied

“We need to start collecting and sharing data in a systematic way to reap the rewards.”



ILLUSTRATION: SIMONE ALTAMURA

machine-learning algorithms to many blocks for which we had actual yield data, so we could assess the accuracy.”

The first part of the analysis used statistical methods to model a mathematical relationship between the different variables. Cumulative leaf area index (from aggregated FruitLook data) had the best correlation with yield of all the variables tested. Similar results were obtained using the normalised difference vegetation index.

Unfortunately, the correlation between predictor variables and yield was strong in only a few cases. “There’s too much variation here,” said Van Niekerk. “Regression is inefficient for such comparisons.” Machine learning performs much more reliably. Using monthly aggregated data, the algorithm attained 89 to 93 percent accuracy in forecasting yield. With weekly data, accuracy was be-

tween 83 and 95 percent.

“We are encouraged by these strong models that we built with only a very few samples,” affirmed Van Niekerk. “However, there were some inconsistencies.” Why is this? Whereas the training set should include 1,000 to 2,000 samples per cultivar per region, Van Niekerk’s team had only 20 to 300. Future research will focus on improving the quality and quantity of data. Automated data collection and greater incorporation of remote sensing technology is planned.

“Clearly machine learning holds much potential for yield modelling,” concluded Van Niekerk, “but there are many other applications we could also be looking at. We need a lot of in situ data and we need to start collecting, collating and sharing such data in a systematic way so we can reap the rewards of machine learning.” •

THE LAY OF the land: GIS, machine learning and fruit fly distribution

talk by Gulu Bekker
summary by Anna Mouton

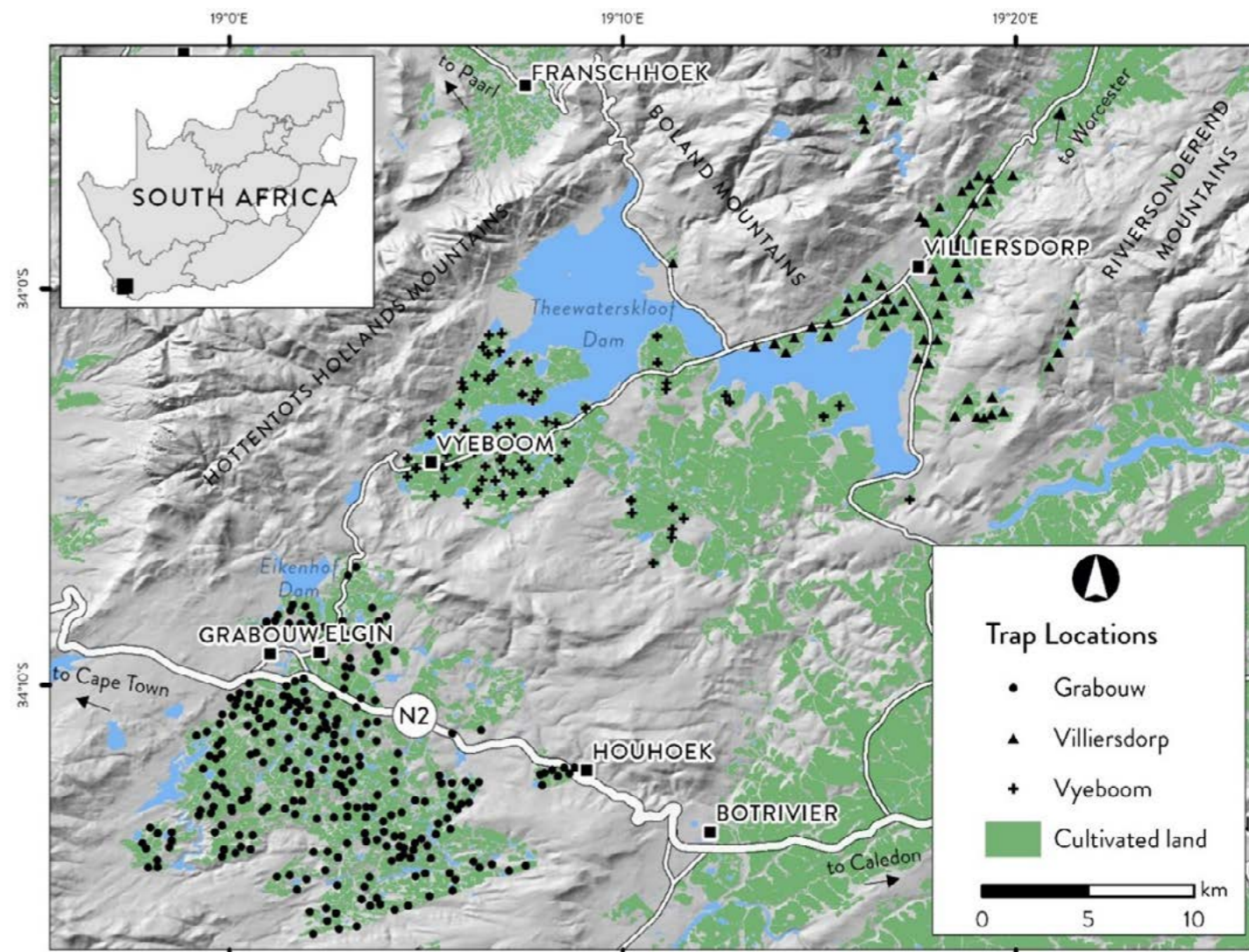
Gulu Bekker from Stellenbosch University described the use of geographical information systems (GIS) and machine learning to study Mediterranean fruit fly distribution. His research took place in the Elgin, Grabouw, Vyeboom, and Villiersdorp (EGVV) area.

“INSECTS –including fruit flies–respond to changing environments,” said Bekker, “and this determines where they find themselves within the system.” Bekker highlighted the complexity of the agricultural environment. Spatial characteristics range from microclimates and soil types to large-scale features such as topography and water bodies.

Bekker’s research focused on the Mediterranean fruit fly or Medfly (*Ceratitis capitata*). Medflies cause significant economic losses in stone and pome fruit production. Female flies lay eggs in fruit and the developing larvae feed within the fruit. Pupation takes place in the soil. Adult flies emerge from the ground and fly off to find mates and continue the cycle. “No fence or wall will stop them from moving around,” remarked Bekker.

“Most control is aimed at the adult stage,” said Bekker. “However, it’s a moving target.” Area-wide integrated pest management (AW-IPM), which proposes to manage the entire fruit-fly population, has been successful, but it poses challenges. AW-IPM has to be applied over a large area and requires substantial logistical and financial inputs.

More efficient AW-IPM requires a better understanding of the spa-



tiotemporal distribution of the flies. “We need to know when and where the pests are within the landscape,” explained Bekker, “but we also need to know why the pest is there. The answers to these questions can contribute to improved decision-making.

“Some of the main factors influencing Medfly seasonal dynamics and spatial distribution are weather conditions and on-farm management actions, both of which can be highly variable within and between seasons, making it very difficult to gauge the impact of these factors on an area-wide scale.”

Therefore, Bekker examined the influence of stable geographical characteristics on Medfly trap catches in the EGVV area. The aim was to identify geographical characteristics that may be predictive of the spatial distribution of the Medfly population.

Weekly trap-catch data was obtained from 399 traps for four consecutive fruiting seasons. The data was captured and analysed using a GIS. GIS enables the visualisation of data in order to find spatial relationships and patterns. “It helps us in our attempts to represent the real world on a piece of paper,” summarised Bekker.

The problem is that the high variability of trap-catch data makes pattern recognition difficult. To counter this, Bekker performed a hot-spot analysis. A hot spot is a statistically significant cluster of high values (whereas a cold spot is a cluster of low values). Hot-spot analysis can differentiate a random spatial distribution from one that is related to an underlying cause.

The monthly and seasonal hot-spot maps for Medfly trap data in the EGVV area showed variation in the location of the hot spots. “But if you

look closely, there was a north-west and a south-east split between hot spots and cold spots,” Bekker pointed out. “Surprisingly, we saw the same split in long-term mean temperature and annual rainfall.”

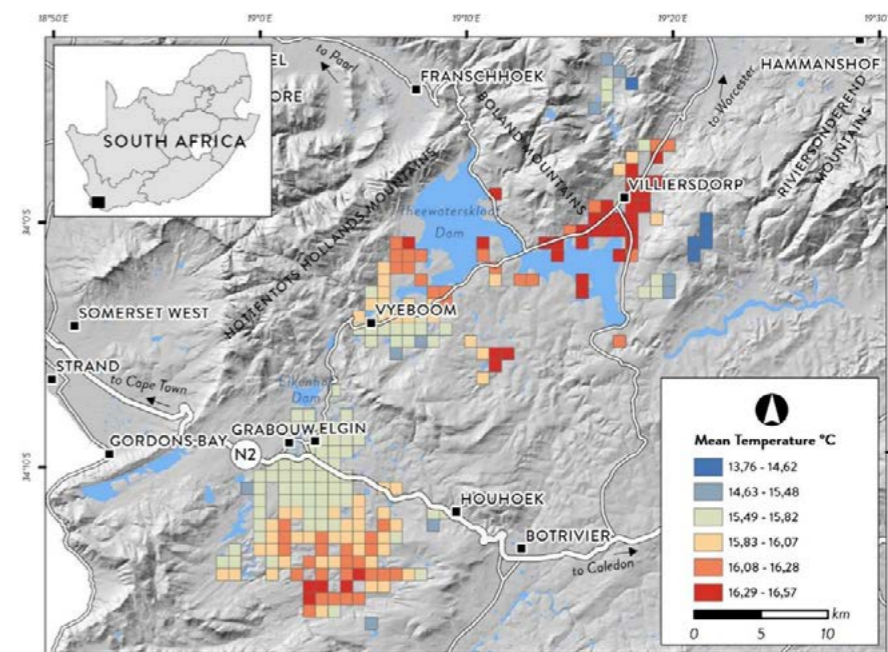
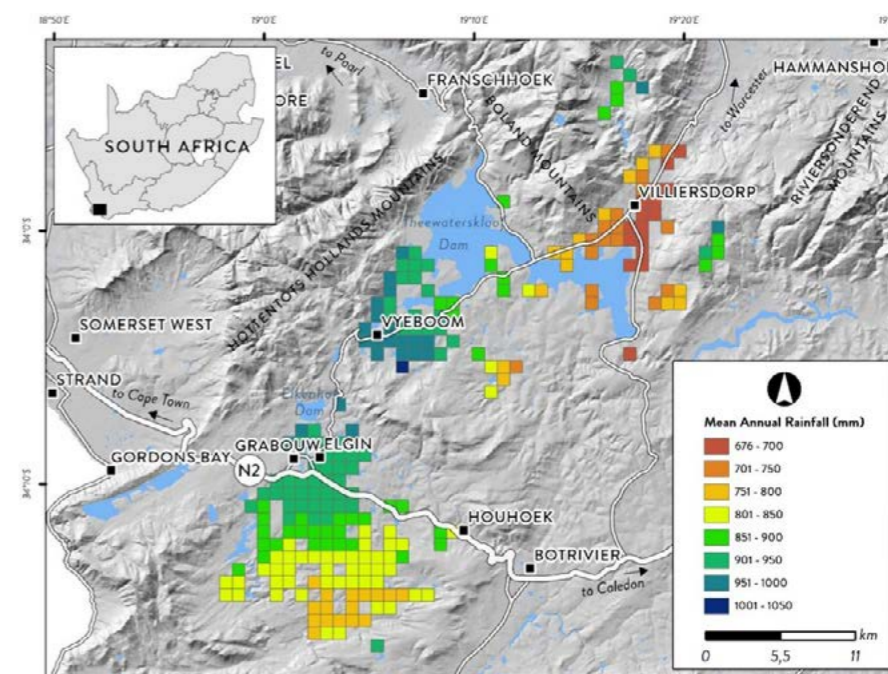
Machine learning was used to determine whether this pattern could be explained by stable geographical variables. “We used the data from the hot-spot maps as known outputs in the random-forest algorithm,” said Bekker, “and the geographical variables as inputs. The algorithm gave an overall model accuracy but also a variable importance list—which is a measure of the role played by each variable in constructing the model.”

The results showed that long-term rainfall is a prominent driver of Medfly trap-catch hot spots and cold spots in the EGVV area. Maximum temperature is also important. “It’s not just one variable that explains these hot spots and cold spots,” said Bekker, “but it’s a combination of a multitude of variables.”

“Within a complex agricultural system we could identify a relationship between the spatial distribution of long-term Medfly trap catches and the geographical characteristics of each zone,” concluded Bekker. “GIS and machine learning proved to be valuable tools in determining and explaining these patterns.

“Hopefully this research will help AW-IPM managers to conduct more precise spatial planning—which could lead to better program performance and reduced costs.” •

Click [here](#) to watch Bekker’s summary on our YouTube channel.



NEW technology in monitoring and spraying

*talk by Gideon van Zyl
summary by Anna Mouton*

Gideon van Zyl, technical consultant with ProCrop, discussed the impact of remote control, remote sensing and automation on application technology in modern fruit production systems.

“I THINK this is the way that farming of the future is going,” announced Van Zyl, gesturing to an image showing sweeping farmlands centrally controlled through remote sensing and automation.

Although unmanned aerial vehicles (UAVs or drones) are already used for chemical applications in some crops, there are limitations. The deposition of aerial sprays is restricted by tree canopies, particularly with stone and pome fruit. When spraying from above, the application is complicated by the number and density of leaves and fruit that intercept the droplets.

Van Zyl gets many enquiries about the use of drones. “We need deposition data,” is his response, “specifically for different parts of the canopy.” Without this, there can be no assurance of effective disease control. Current drones also have small payloads (30 to 60 liters of spray product). This excludes their use for most application situations.

Whereas data is lacking on the use of drones, more information is available for remote sensing technology. “This is where research in spray application has been moving,” said



Van Zyl. The focus is on crop-adapted application, in which concentration and spraying are adjusted for the size and geometry of the canopy.

Tree-row-volume (TRV) is considered when planning chemical applications, but it is calculated on an orchard basis. "Imagine if you can do it for every tree, in real time, as the unit is spraying," said Van Zyl. "If we can do that, we can determine the volume, canopy density and leaf area. We can stop dosing per hectare and start dosing per square centimeter of leaf area that we need to cover."

Crop-adapted application based on real-time sensing leads to more efficient spraying – time is saved on measurements, calculations and refilling; and the process uses less diesel and chemicals. Less chemical use is better for the environment as it reduces run-off and pollution. In addition, chemical application is more accurate.

The main systems for characterising plants rely on various types of sensors linked to electronic data collectors. Digital cameras are low-cost, easy-to-use and provide acceptable accuracy for estimating variables such as plant height, volume and leaf area index. However, digital photogrammetry requires a large number of images and complex post-processing which precludes real-time use. Stereoscopic systems overcome some of these limitations, but lose effectiveness under certain conditions such as variable lighting.

"We use digital photography every day to measure deposition," said Van Zyl. "This is a service that Stellenbosch University provides to growers." The digital image analysis laboratory of the Department of Plant Pathology can measure deposition quantity, quality and uniformity. A smartphone and web tool called SnapCard is also available – from the App Store or Google Play – for assessing spray coverage.

Technologies that are currently under investigation are light detection and ranging (LIDAR) and ultrasonic sensors. The first variable delivery machine with adjustable liquid flow rate nozzles and airflow louvers has already been developed. Spray rates are matched to individual tree size and density using real-time data obtained from a LIDAR system. The machine only sprays where it detects leaf area.

"With our canopies changing – as we move to high density orchards – is the TRV system still relevant?" Van Zyl asked the audience. "There are other calibration models that have been used successfully in other countries."

The MABO (Marktgemeinschaft Bodenseeobst) dos-

ing model adjusts water volume based on canopy characteristics by manipulating forward speed and power take-off revolutions per minute. MABO reduces fuel, time and labour inputs and generates less spray drift than conventional systems. Calibration discs are another tool for calculating total flow and flow per nozzle without the need for a calculator. Electronic flow meters are available for measuring nozzle output.

Patternators are useful to quantify deposition patterns, but can be expensive. Van Zyl pointed the audience to an [online resource for free patternator building plans](#).

"The future is here," concluded Van Zyl. "In the next few years we are definitely going to move into automated spraying. Until then – focus on improving your calibration!" •

Click [here](#) to watch Van Zyl's summary on our YouTube channel.

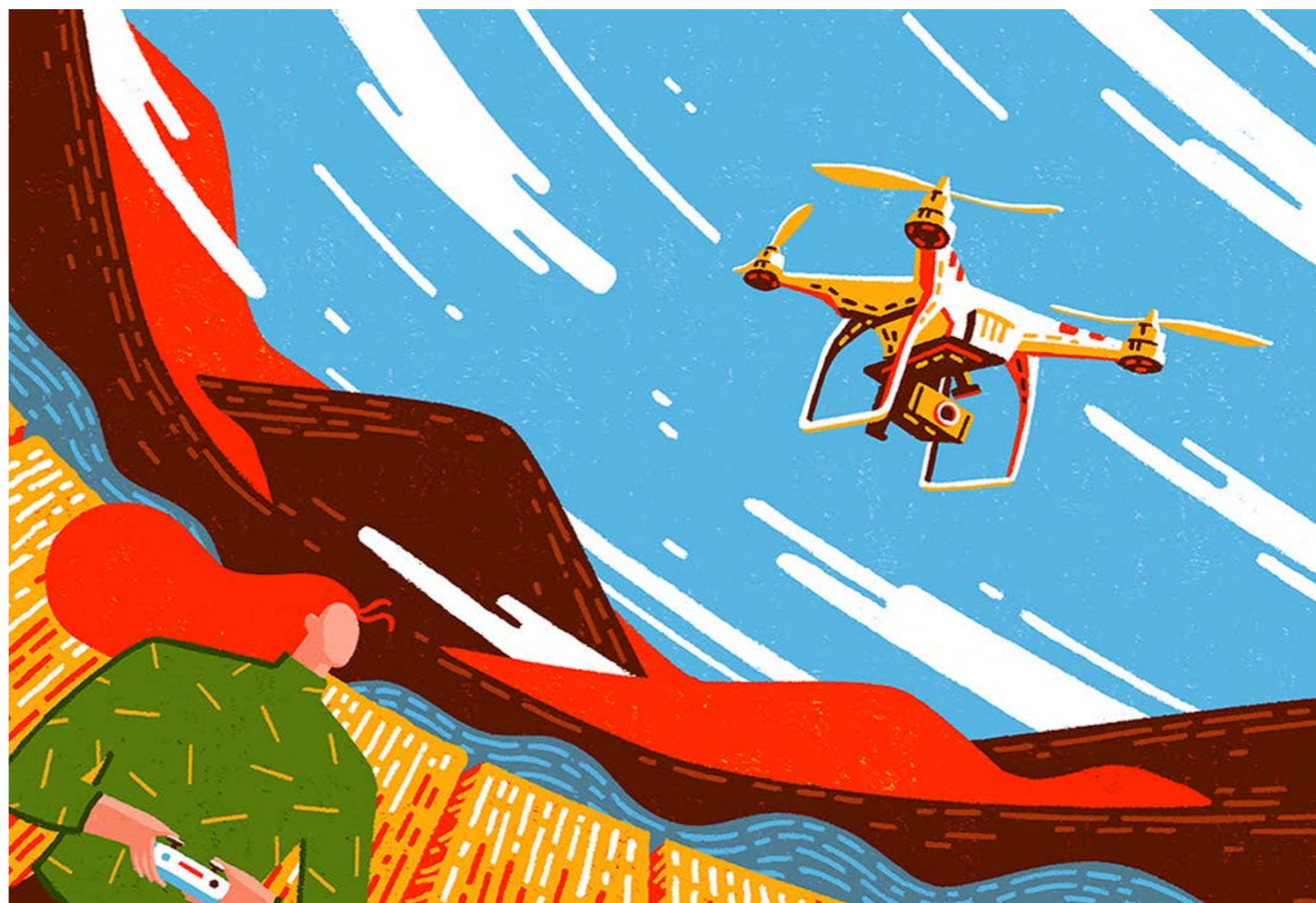


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MORE RESOURCES

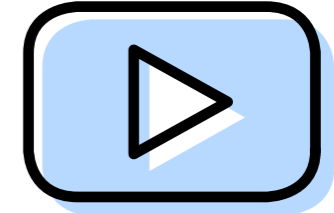
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