HORTGRO SCIENCE

IRRIGATION SEMINAR 2017 SUMMARY REPORT

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Growing Fruit IQ

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FARM PLANNING

GET ALL THE EXPERTS AROUND THE TABLE, SAYS DAAN BRINK

THERE was once a coastal wine farm that was set for success, because it had the best soil possible. A top viticulturalist and one of the best soil scientists that money could buy were contracted. Both did an exceptional job to provide the farm owner with information about the best cultivars to plant, and the slopes, soils and layout of the area. Unfortunately, the two experts were like ships passing in the night and never got round to talking to each other about what would be best for the farm. The business eventually failed, because the wrong cultivars for the particular soils were planted.

With this cautionary tale soil scientist Daan Brink of Fruitmax Agri ended off his address at the HORTGRO Science Irrigation Seminar. He used it to illustrate how important it is that all experts and consultants from different fields working on the same farm pool their knowledge and share their ideas.

"Everybody must be on the same page about where you are going to plant or not, and what will work best," he said.

Brink highlighted the value of a detailed soil profiling exercise when especially costly developments such as new irrigation blocks are considered. Such an exercise will also help producers to understand whether their current irrigation system is effective or not.

Brink says it makes no sense to do such crucial work in isolation. Results from a soil profiling exercise must form part of an integrated plan that considers the future of a farm. Possible production areas with for instance poor water drainage issues can be pinpointed, as well as areas with soils that have too much clay that might need additional ridging to ensure better water penetration.

"It doesn't help to just send a few emails with suggestions around to one another," he reiterated. "It remains the farmer's responsibility to get the soil scientist, the irrigation specialist and the person who recommends which cultivar to plant all around the same table."

DOES CULTIVAR CHOICE MAKE A DIFFERENCE?

Research by the Water Research Commission has shown that there is no major difference in how much water different apple cultivars need. It is therefore better to consider soil, micro climate and irrigation design rather than cultivar choice when a new irrigation block is planned.

SOIL ANALYSIS 101

Brink says that the current drought forces producers to irrigate less, and to do so more effectively and deeply according to the plants' root structure. Deeper root systems are going to play an increasingly important role during times of drought, and will ensure optimal water take-up by plants.

He says that an in-depth soil analysis considers various aspects that are helpful in the planning of an irrigation block.

- Soil depth influences how deep plant roots can penetrate into the ground and their subsequent take-up of water.
- Colour of the soil – the redder, the better. It indicates lack of leaching and better aeration.
- Generally, the volume and types of coarse fragments limit the water holding capacity of soil. Western Cape soils in particular are known for their high rock contents. In some cases, such coarse fragments can be positive, as in clay-rich soils where they allow for better aeration and water penetration.
- The clay content of the soil influences its water holding capacity and the cation exchange capacity (and therefore its potential to store nutrients).
- Subtle differences in underlying soil layers can hamper water flow from one layer to the next. Therefore, soil must be broken up efficiently before planting can start.
- If an area is too wet in winter, the plants will not send down roots deep enough to also survive in summer.
- Drainage options – the more, the better.
- Texture and structure influences the ability of the soil to hold onto water. The more granular the soil, the higher its permeability, but the lower its ability to absorb water.
- The more compact and dense the soil, the more difficult it is for water and air to penetrate.
- An investigation into the mother material takes note of whether it is hard rock, weathered rock or shale.
- Signs of leaching indicate that there is water in the system. Pay attention to how and where the leaching takes place.
- The volume of organic material is not only important for the top soil layer, but also for lower layers.
- Cementation sets in when soil layers harden when calcium, iron, magnesium or even organic matter are present. It can become impenetrable.
- Biological tests take note of the presence of specific diseases and organisms, such as Phytophtera and apple replant disease.
- The chemical balance in the soil must be tested. Too much phosphate can for instance negatively influence the uptake of other elements by apple trees.
- Roots do not develop well when soil temperatures are too high.
- The slope of a particular block influences soil temperatures. Northern slopes are normally warmer than southern ones.
- Wind conditions need to be taken into account as well as the possible need for wind breaks.

WATCH BRINK'S PRESENTATION ON OUR YOUTUBE CHANNEL HERE.

IRRIGATION DESIGN

PIPELINE ECONOMICS: CHEAPER ISN'T ALWAYS BETTER

A CHEAPER option today might cost more tomorrow, and turn out not to be the most financially savvy option after all. This is according to Dynamic Irrigation advisor **Werner de Leeuw den Bouter**, who spoke at the recent HORTGRO Science Irrigation Seminar.

He advised producers to weigh up the long term financial implications of different irrigation systems, and to keep aspects such as annual electricity tariff increases in mind.

To install a system that uses a smaller diameter pipe and larger motor size (which will consume more electrical power in the lifetime of the system) can save a farmer up to 49% in the initial layout costs. Such a water delivery system however needs to run on a higher pressure to irrigate an area effectively, and will therefore use more electricity. A bigger pipe size has lower pipe friction, and therefore consumes less electricity.

De Leeuw den Bouter says that when annual operational costs are included in a optimisation calculation, a bigger pipe and a smaller motor size makes the system financial more feasible in the long run.

He added that aspects such as the annual irrigation requirements, the application rate of a system, evaporation and transpiration rates and the type of crop to be planted also need to be considered when an economic block size is calculated.

A FEW THOUGHTS ON THE DESIGN OF IRRIGATION BLOCKS

- In your block layout, spend time considering your soil maps to ensure that all soil types are considered.
- Newer block rows should not be longer than 100 meters.
- The current recommended design norms applicable for drip irrigation systems and micro-sprinkler systems are available from the South African Irrigation Institute here. These were newly revised in May 2017.

WATCH DE LEEUW DEN BOUTER'S PRESENTATION ON OUR YOUTUBE CHANNEL HERE.

WHAT IS THE ESTIMATED LIFE SPAN OF AN IRRIGATION SYSTEM?

Drip systems	5 - 15 years
Subsurface drip	10 years
Micro	15 years
Permanent sprinklers	15 years
Dragline	10 years
Quick coupling	12 years
Centre pivots	15 years

PVC PIPE BASICS

According to the latest revised design norms, the theoretical correct calculated flow rates for specific PVC pipe sizes are as follows:

- 110/6 PVC = 25m³/hour
- 125/6 PVC = 35m³/hour
- 160/6 PVC = 65m³/hour

APPLICATION RATES: HOW TO DO THE CALCULATIONS

Use the following calculation to work out the application rate of a system:

$$\frac{\text{flow rate (L/h)}}{\textbf{row spacing (m) x sprinkler spacing in row (m)}}$$

Example: $\frac{30L/h}{4m \times 1.5m} = 5mm/hour$

- 4m x 1.5m
- 5mm/hour x 10 = 50m³/Ha/hour

The flow rate of a 0.90 hectare block is calculated as follows:

Application rate (m³/Ha/hour) x **block size** (Ha)

Example: 50m³/Ha/hour x 0.90Ha = 45m³/hour

MICRO-IRRIGATION OPTIONS

TIME TO RETHINK THE USE OF LOW VOLUME-IRRIGATION SYSTEMS

RETHINK your stance about low volume-irrigation systems that deliver water in a targeted and controlled fashion to a plant's root zone. Resistance towards such irrigation systems are fast becoming outdated, because water is becoming an increasingly scarce resource.

This was the message from **André du Toit** of Netafim, an international company that has pioneered especially drip irrigation technology worldwide since 1964. In 2017, it celebrates 25 years of doing business in South Africa.

In his talk at the HORTGRO Science Irrigation Seminar, Du Toit provided basic guidelines, conditions and situations to consider before deciding on installing a drip irrigation system or a micro spray head system. In both cases, soil properties are a major consideration.

In lighter soils, drip irrigation provides water to a narrow strip of soil. This penetrates quicker and deeper towards the roots. Heavier soils allow for a wider spread of water, but do not necessarily translate into good penetration.

Du Toit advised that producers using low volume irrigation look carefully at the delivery rate and spacing of the emitters being used. The flowrate to the block will determine the amount of time needed to supply in the daily water requirements of the plants being irrigated. Aspects such as the percentage of rock in the profile, as well as the water holding capacity of the soil influences the frequency of the pulses being delivered. The depth of the roots will determine the pulse length.

"Water applied does not always mean water available for uptake," he noted.

According to Du Toit, different delivery rates can be chosen when using drip irrigation. Adjustments can therefore be made to take different soil properties into account.

"The rate at which water is delivered influences whether it will only spread across the surface or can actually penetrate deeper underground to where the roots are," he explained.

Du Toit advised producers to consider different dripper spacing and the use of multiple lines to increase the volume of soil being watered when using drip irrigation. "Growers should be looking at different options and therefore consider different dripper spacing."

He explained that micro-sprinkler systems use momentum to "throw" water from a swivel head. The water coverage these provide depends on the type of swivel head being used. Different swivel heads are available to reach targeted root zones, each having different distribution patterns. These swivels can be replaced to suit the changing targeted root zone area, as the plant increases in size. In some cases, a deflector can be removed to change the wetted diameter.

Full coverage micro sprinklers in orchards will increase water losses due to evaporation.

Du Toit noted that the width of ridges in an orchard influences how much water goes to waste and evaporates. This can be as much as 40% for a two meter ridge when using a swivel that spreads the water too far and exceeds the root zone.

According to Du Toit, devices such as probes that measure soil moisture are only helpful when these are placed correctly. "Where the probe is placed in terms of the dripper or the micro-sprinkler determines the reading you will get," he warned. "If your probe is not placed correctly in terms of the root structure, your measurements and subsequent irrigation scheduling will not be effective."

WATCH DU TOIT'S PRESENTATION ON OUR YOUTUBE CHANNEL HERE.

RULES TO CONSIDER WHEN USING MICRO-IRRIGATION SYSTEMS

- Use the full area application rate (and not the wetted area application rate) to calculate a plant's water requirements. Use this calculation:
  – Delivery rate in litres per hour / (emitter in-row spacing x row width) in meters = mm/h
- An orchard's tree spacing and leaf canopy volume influence calculations about how much water it needs.
- Choose an irrigation system that allows for fewer but longer periods or pulses of irrigation.
- Mulching helps minimise water evaporation.
- Do not irrigate past your root zone (except when you want to create a wet buffer zone around the deepest root sections).
- When applying fertilizer along with the irrigation water, make sure that the enriched water spreads through the whole block. Watch out when using short pulses - the fertilizer might not be delivered properly because the travel time through the system is too short. Be wary of overwatering the plants during this fertilization process.

CUSTOMIZING IRRIGATION MONITORING AND DATA INTERPRETATION

IRRIGATE-MONITOR-ADJUST: THE IRRIGATION CYCLE

TO APPLY water is easy, to irrigate effectively is the challenge.

This is the view of Mico Stander, consultant at Agrimotion. Stander and his colleague Tiaan Snyman gave an overview of how local fruit farmers can approach their irrigation monitoring and scheduling during a recent HORTGRO seminar held near Franschhoek.

“To schedule, one has to look at applied irrigation, soil moisture and weather predictions,” Stander says. “Customise your monitoring system. The more the better - use field observations, probes and data services like FruitLook to provide a full picture. It these tools provide different results, investigate what is going on in the orchard.

“Giving two hours irrigation every Monday, Wednesday and Friday with an extra hour if it is hot is an irrigation roster, not scheduling,” he said. “An irrigation schedule is when you manipulate the soil moisture, according to the soil and climatic conditions, and the phenological stages of plants, to stimulate the desired response in crops.”

Stander says it is important to monitor the water applied in the orchard, as well as the soil and plant response to it while considering weather conditions.

He gave an overview of some of the monitoring tools available to local farmers, including soil based and atmospheric based methodologies.

Effective irrigation scheduling is a sequence, he says. “We apply water, and then we need to track what happens in the soil as well as how the plant responded to this action. Depending on this, we need to adjust our schedule.” This approach to irrigation enables a farmer to be more accurate and use water efficiently, he believes.

Farmers need to monitor soil moisture in order to adjust their irrigation based on what is happening in the atmosphere and what the plants will need in the week ahead. “Also, producers need to make sure what phenological stage plants are in so that they can know what effect a decision to under-irrigate will have on plants.

We have to evaluate what the soil and plant response were to the past week’s irrigation. Then, with the forecasted weather in mind, evaluate it. Adjust accordingly and repeat the cycle.

Snyman explored what ‘weapons’ farmers have in their arsenal to monitor irrigation. This includes using field observations, tension-meters, wetting front detectors and capacitance probes to track soil moisture. Snyman considers a capacitance probe as especially useful to inform farming decisions. It provides real-time data and is effective to inform decisions on irrigation scheduling, he says. The newest development taking off is phyto-monitoring. This concept refers to a real-time information system that measures sap flow, fruit growth, stem diameter and soil moisture. This information will improve our knowledge of how plants respond to different inputs like irrigation. This method has been in use in the greenhouse industry to manipulate temperature and nutrition.

Remote sensing can also give a farmer a more realistic view of an entire orchard, he explains. A range of spectral indexes is available, including the ‘normalised-difference-vegetation-index’ to analyse remote sensing measurements. Data services like FruitLook as well as drones are also available to inform irrigation decisions, he says.

WATCH SNYMAN AND STANDER'S PRESENTATION ON OUR YOUTUBE CHANNEL HERE.

Snyman says a weather station is one of the most important tools producers can have in their arsenal to provide information about temperature and relative humidity. “These give us a road map for irrigation scheduling,” he says. “Service providers give excellent forecasts with weather stations accurately recording actual farm conditions. This is crucial in assessing and adjusting irrigation schedules.”

Various factors must be considered when farmers customise their monitoring system, he says. This includes their budget, labour and time available, the detail needed (daily versus weekly), the data value (accuracy and application) and how accessible technology and service providers are in their particular region. “In practice, this means a farmer can have a basic system or something more complicated and expensive that needs more interpretation.”

Farmers need to measure their applied irrigation from last week, he emphasised. “Then they need to compare their planned schedule to the actual irrigation to look at any deviations. Do your field observations and monitor probe graphs. Adjust your plans according to predictions of the next week’s weather. Note increases or decreases in evapotranspiration, warmest days and rainy days, for example. Repeat this (irrigation) cycle weekly.

“If you want to upgrade your standard system, add a capacitance probe. A field observation is like a photograph of what is happening whereas a capacitance probe is like taking a video. If they don’t provide you with the same picture, go back and have a second look.”

WATCH GOUDRIAAN'S PRESENTATION ON OUR YOUTUBE CHANNEL HERE.

FRUITLOOK AS A HELPFUL TOOL

FRUITLOOK 'SUPPORTS EFFICIENT FARMING'

SATELLITE derived data offered by FruitLook provides producers with the opportunity to farm more efficiently. This is more relevant than ever as the current water crisis in the Western Cape continues.

"The more producers know about their farms by monitoring it, the more informed their (management) responses can be," says Ruben Goudriaan from the Dutch company eLEAF. eLEAF, in collaboration with a local team, provides FruitLook, an online data service that is available to farmers in the Western Cape.
"FruitLook helps farmers to save water and improve their productivity by enabling improved management of resources."

FruitLook uses satellite-derived information to help farmers decide about optimal timing, extent and location of inputs such as water and fertiliser. It is thereby helping to take some of the guesswork out of irrigation and enabling farmers to use water more efficiently. This is possible thanks to the collation of satellite derived information that is not always visible to the naked eye.
"FruitLook, for instance, allows a grower to see where an orchard or vineyard has received sufficient or insufficient irrigation and if every part of the block is growing optimally," says Goudriaan. "The service includes data maps on, among others, biomass production, actual evapotranspiration, evapotranspiration deficit, biomass water use efficiency and nitrogen contents."

FruitLook can be used in many ways. Firstly, it can be used for regular check-ups on orchards or vineyards. "Every week FruitLook allows a grower to check last week´s block development. It provides a simple procedure to producers to check whether a block is growing optimally," says Goudriaan. (FruitLook can therefore help map problems in a block, but does not allow for investigating the cause – that has to be done in the orchard.)

Secondly, the graphs it generates help farmers to recognise these issues, but also to compare blocks with each other. "This enables you, for instance, to identify stressed blocks and compare growth between blocks. This can help determine over or under irrigation or developmental problems."

FruitLook has proven useful to understand spatial-temporal growth variation on farms. Growth variation in a block is often caused by in-field variation in soil. This variation in soil reflects in weekly data maps of growth and water use.

It can also help farmers identify and understand this variation, which will help them decide on where to place probes, take leaf or soil samples or even during the design of new irrigation blocks.

Goudriaan believes the optimal use of the limited irrigation water available this summer (due to the drought) will be crucial for farmers to produce a quality crop given the water restrictions in place. "This is where FruitLook has proven especially useful to many local producers. It can be used for the placement of soil moisture probes, the detection of irrigation and drainage problems and to evaluate how efficient irrigation regimes are, in the current and during previous seasons. This all starts by assisting irrigators to manage their limited water resources in the upcoming irrigation season in a more efficient way. We are here to support farmers make the most of it," he concludes.

- The Fruitlook system, subsidised by the Western Cape Department of Agriculture, gives farmers access to high-end satellite monitoring of their crop production at no cost. During the 2016/17 growing season, it covered close to 200 000 ha of fruit crops and 5.7 million ha in total (including natural areas).
- Fruitlook provides data maps describing crop growth, water use and leaf nitrogen content. It integrates satellite data with geographical data and weather information in complex models and produces farm-specific data maps which are presented to the farmer on a weekly basis via a website (www.fruitlook.co.za).
- There are now seven years of data available for use by farmers and researchers. As such, FruitLook has one of the best fruit-related databases in the province. The face of natural resource management is changing with satellites and remote sensing playing an increasing role to inform decision making on farms. It also allows farmers to take a long-term view by looking at data captured across multiple seasons.

WATER AVAILABILITY: FUTURE OUTLOOK FOR THE WESTERN CAPE AND IMPLICATIONS FOR FRUIT GROWERS

WATER STORAGE 'SHOULD BE A PRIORITY' – FARMER

GIVEN climate realities, water storage capacity in the Western Cape has to be increased drastically to ensure that producers have security for at least two years during future dry spells.

This is the opinion of Marinus van der Merwe, a fruit farmer from Vygeboom. Van der Merwe, a member of Agri Western Cape's Natural Resources Committee, discussed future predictions and impacts of water availability for fruit farmers at HORTGRO's recent irrigation seminar.

Changing farming conditions due to climatic shifts are already a reality for local producers, he points out. Globally, the year 2016 was the hottest year ever recorded, surpassing the high temperatures of 2015. Unfortunately, droughts like currently experienced in our fruit growing regions might not be isolated events in the future. "Climate models predict a gradual to rapid change in climatic conditions and an increased likelihood of extreme weather conditions like hail, flooding and prolonged droughts in the Western Cape. Without more rainfall in the coming months, producers are up for another challenging season." Decreased winter rainfall is predicted for the Western Cape in future, which may have a dramatic effect on horticultural farming in the Western Cape."

THE CURRENT WATER CRISIS HAS BEEN MADE WORSE BY "YEARS OF DENIAL"

In future, balancing the needs of irrigation farming and bulk consumption as well as water trade between catchment areas will be crucial. Says Van der Merwe, "The expected water trade-off between the primary agricultural and rural areas and the city basin (Cape Town) is severe."

The current water crisis has been made worse by "years of denial", he believes. "The question is how much was done to plan for this and how this risk is now impacting on us (the agricultural sector)."

Although farming is a "huge contributor" to social and economic welfare in South Africa, its value is "still often underestimated" by politicians. Van der Merwe says this is reflected in the debates about water use and priorities when water allocations are made.

"Our agricultural industry and the downstream value chain is the backbone of our rural economies. Without it, we are facing devastating social-economic effects." Agriculture in the Western Cape generates R18,6 billion of the country's gross domestic product, he points out. It also contributes a fifth (20%) of the agricultural sector's contribution to the national gross domestic product. The horticultural industry is particularly important to generate jobs and as a responsible steward of natural resources. "Yet agriculture is on the receiving end of some blame (regarding dwindling water supplies)," he says. "It gets blamed for the current crisis, yet the urban use of water resources is on the rise."

Currently, the combined water storage available in the province is 272,86 million m3, only half of all the water that has been allocated for abstraction. "This year authorities budgeted for 389,7 million m3 for urban abstraction and about 162 million m3 for agricultural abstraction. In total, water allocations of 568,50 million m3 have been made. This will mean drastic water restrictions are on the cards to meet the demand," he points out.

"It seems as if the proverbial well ran dry over the last decade. Also, the projects crucial to provide the much needed spare storage capacity and buffer supply were postponed or never realised. We are in a sense experiencing a perfect storm. Has enough been done to mitigate this risk for agriculture?"

The Western Cape is a time bomb of congestion of municipal infrastructure and resources that must be managed accordingly, he argues. "We need additional water storage capacity for at least two years. This is key to the survival of irrigation farming in the Western Cape. We also need a shared vision, true leadership and aligned priorities," he says. "This will be of great importance to keep our rural economies alive."

Van der Merwe believes the local fruit industry is "well positioned" to take part in building the green economy and act as a responsible water steward. "The sector will have to keep on lobbying for agricultural water use. We (producers) must put ourselves in the position to justify our stewardship, working sparingly and wise with the resource.

"We should also keep investing in better solutions. But to be successful, we really need government and policymakers to be pro agricultural and pro economic development.
As an industry, it is important to do this. We cannot eat water."

WATCH VD MERWE'S PRESENTATION ON OUR YOUTUBE CHANNEL HERE.

FUNCTION OF WATER DURING DIFFERENT PHENOLOGICAL STAGES

PHENOLOGY AND WATER IN THE FRUIT TREE

Professor Stephanie Midgley of the department of horticultural science at Stellenbosch University discussed the role of water at different phenological stages. She showed how drought stress impacts on plant performance during the production cycle.

"EVERYTHING starts at the leaf surface, the stomata," Midgley began. She explained that the air outside the stomata contains less water vapor than the air inside the stomata. As a result, when the stomata are open, the leaf loses water. The tree replaces this water by drawing more water up from its roots. It becomes part of "a continuous column of water from the soil into the atmosphere."

Light is the most important factor initiating transpiration. The trees open their stomata in response to light, so that they can take up carbon dioxide for photosynthesis. High temperatures, low relative humidity and wind increase transpiration rates, as do a large canopy and heavy crop load.

Apple trees need large amounts of carbon dioxide. They keep their stomata open for as long as possible, even in the face of a water deficit. "Apple trees are unusual in that they are quite tolerant of a daily water stress developing, even if the tree is well-watered," Midgley clarified. When the vapor pressure deficit becomes insupportable, trees start to close their stomata. This typically occurs around noon for a mature tree on a hot day. It leads to a depression of photosynthesis that continues throughout the afternoon.

Midgley noted that "it is very important to define what we mean by stress in apples." She considers a water potential below minus 2.5 megapascal in the xylem in the middle of the day as the starting point of stress.

Midgley also discussed seasonal changes in transpiration. Transpiration increases from spring onward and peaks in December. Thereafter, it decreases, stopping when leaves fall in autumn. A tree with a full canopy transpires most during warm months with high light levels.

The second part of the presentation dealt with the impact of water stress on different phenological processes. The focus was on pome fruit.

"The first 40 to 50 days after full bloom is an absolutely critical period," Midgley emphasized. "Any water deficit in that period has a direct impact on not only fertilization and fruit set, but very particularly the process of cell division." Cell division can only occur when cells are fully hydrated. Water stress will lead to poor fertilization and insufficient numbers of cells in fruit. Fruits that have low cell numbers cannot recover to become large fruit at harvest. Midgley added that this period is also critical because transpiration drives sap flow. Sap flow brings nutrients from the roots to the sprouts.

"IN THE FINAL GROWTH PHASE WHEN THE WHOLE FRUIT IS GROWING VERY RAPIDLY, THAT IS WHEN YOU NEED A LOT OF WATER."

However, as stated by Mico Stander of Agrimotion in his talk, the cell division stage is when growers can sometimes save water. This is because the tree has a relatively low water requirement at this stage due to the canopy still developing. Also, the soil may still be wet in the Western Cape due to winter and early spring rain. Hence, growers may potentially supply water in excess of what is required during this stage. However, as stated by Midgley, drought stress at this critical stage is very detrimental to fruit size so water saving is only possible if the needs of the trees are met.

Flower bud initiation is the next important period that is sensitive to drought. It occurs in the middle of summer. Bud development, in late winter and spring, is less affected by water stress.

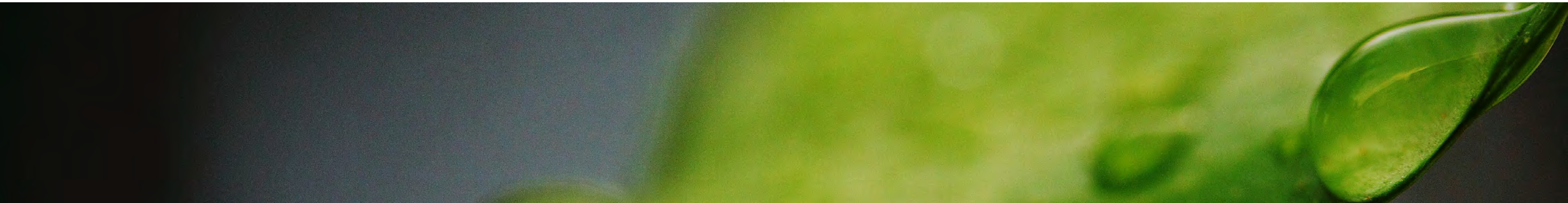
Midgley identifies the last stages of fruit enlargement as the third sensitive period. "In the final growth phase where the cells are swelling out and the whole fruit is growing very rapidly in terms of volume, that is when you need a lot of water."

Midgley draws attention to the importance of processes that occur after harvest. " Just a warning note, that the post harvest processes are incredibly important and if trees are stressed at that point, obviously we are going to have effects on the root growth, on reserve accumulation, and on bud development. That is something that we are not used to in the Western Cape and I think we need to start looking at whether our trees are starting to become stressed in the post harvest period and for how long."

In conclusion, she considered whether there are periods when trees need less water. "Yes, there are. In apples it's a bit more tricky than in stone fruit, but certainly for the longer season apple cultivars, you have a period between the end of cell division, but before the fruit really starts swelling out quickly in terms of volume growth."

"So, reduce irrigation in that period between cell division and the next phase that is sensitive, that of bud initiation. This is a short window where people have tried regulated deficit irrigation and all you do is reduce shoot growth, vegetative growth, and you don't have a negative impact on the fruit development, during this phase of low fruit growth." However, in practice, it may be quite difficult to focus on this stage in terms of water saving and the irrigation strategies discussed by Jan Rossouw in his presentation might be easier to apply.

WATCH MIDGLEY'S PRESENTATION ON OUR YOUTUBE CHANNEL HERE.



STRATEGY FOR IRRIGATION PRACTICES DURING DROUGHT WHILE CONSIDERING PLANT PHENOLOGY

DEVELOPING A DROUGHT STRATEGY BASED ON PLANT PHYSIOLOGY

Mico Stander from independent consultancy Agrimotion spoke about developing a drought strategy. A successful strategy starts with understanding the phenology of the fruit tree.

"IT'S VERY important for us to know what's happening in our crop at a specific time of year, because if we do something right, or if we do something wrong, that is going to have an impact on various processes in the plant," Stander told the audience.

"At the same time when we have fruit cell division, it could be overlapping with flower induction, and then initiation is more or less the same time as we start rapid fruit growth and it's toward the end of shoot growth. So, it's shoot growth and fruit growth and flower bud initiation that are all affected, depending on the degree of stress that you allow."

Apples undergo cell division in the first 40 days after full bloom. In the next 40 days, rapid cell enlargement takes place. These are critical stages. Stander explained how irrigation stress at these times can lead to losses later. Intervention after the impact occurs will not reverse the damage.

A controlled irrigation deficit up to 40 days after full bloom will reduce vigor. Less shoot competition may stimulate cell division. However, cell division is quite sensitive to water stress and decreasing irrigation below want the tree needs at this point may have a very negative effect on eventual fruit size. Between 40 and 80 days after full bloom, moderate stress reduces fruit size. Fruit size is also decreased by moderate stress during ripening and early ripening may occur. Post harvest, moderate stress limits the formation of reserves.

Severe stress at all stages can lead to fruit drop. Shoots may die back, trees can suffer sunburn and lose vigor and reserves. It is difficult to define stress as moderate or severe. Root development and water infiltration determine the effect of irrigation deficits on stress. Orchards on shallow soils will be at greater risk of drought stress than those on deep soils. Sandy soils hold less water but allow for deep root penetration.

Stander went on to show how the above concepts apply when developing a drought strategy. The goals are to maintain profitability, minimize economic losses and maximize tree survival.

"Water budgeting is exactly what we all need to do. As farmers, I hope you are budgeting," Stander smiled. "Financially, you need to make sure that you can get through the season."

"Water budgeting generally isn't done because our allotment is usually enough, or too much, and we make it through. What we need to do this season is decide how much water we will allocate to which orchards." Since it is difficult to decrease irrigation in pome fruit trees according to phenological stages, it is easier to rather decide on orchards that should get their full allotment of water compared to those that should receive less or those that should be removed.

His method for drawing up a water budget consists of five steps.

1. Determine water use, per block, per week, in the previous one to three seasons.
2. Determine the income and yield, per block, in the previous one to three seasons.
3. Calculate the income and yield per unit water, per block, up to harvest.
4. Rank the blocks according to the income per unit water.
5. Class the blocks according to strategy:
   Class 1: Optimal management, maintain optimal profit.
   Class 2: Reduce yield, maintain marginal profits.
   Class 3: Remove harvest, cut canopy back, keep orchard alive.
   Class 4: Do not irrigate, remove orchards.
   Class 5: Non-bearing, irrigate sparingly to preserve vigor.

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Stander worked through a detailed example to show how to calculate a water budget. "I would recommend that you have your applied water per block on a weekly basis. This will allow you to group and add the water up for each phenological stage, for each block, as these won't be the same for all of your orchards."

Farmers can also apply many water saving practices to complement their water budgeting. Stander provided a comprehensive list of potential measures:

- Mulch and remove weeds and cover crops.
- Target shaded leaves first during summer pruning. Shaded leaves are less efficient in using water than leaves in the sun.
- Severe summer pruning increases the risk of sunburn. Paint trunks white to protect them.
- Stander recommends the use of Regalis to decrease vigor.
- In autumn, forcing trees into early dormancy will reduce reserves, but save water.
- Stem renewal of young orchards will delay their crop for one year, but reduce water use.
- Feed the trees in small portions. A single large feed can stimulate excessive shoot growth.
- Remove fruit as required by the water budget.
- Irrigate at night to decrease evaporative losses.
- Adjust irrigation to reduce water delivery and wastage.

Finally, Stander compared two irrigation strategies. In partial root zone drying, one side of the root zone receives water and the other not. The watered side alternates every one to three weeks. Pome fruit resent partial root zone drying.

In deficit irrigation, less water is applied but to the entire surface of the root zone. The water will not penetrate to the deepest roots. Deficit irrigation causes stress, but is less harmful to pome fruit than partial root zone drying.

PRACTICAL EXPERIENCE REGARDING THE EFFECTS OF DROUGHT AND DROUGHT MANAGEMENT

A FARMER'S PERSPECTIVE ON DROUGHT MANAGEMENT

The seminar culminated in a talk by respected fruit grower Jan Rossouw of Lindeshof. He opened with a slide showing a farmer drinking the water from his rain gauge. "Fortunately, I haven't gone that far," he remarked.

"WE CAN probably all agree that facing drought, as we are facing now, is definitely not going to be moonlight and roses," Rossouw said. "The farm that I am managing over a number of years, scientifically calculated from sand to the heaviest soils, could do well with an average of 9 500 cubes per hectares. The 2016 season, we had 4 500."

He went on to list the possible impacts of water shortages. These include reduction in crops, smaller fruit and poor fruit quality. Drought stresses trees and complicates their management. This all contributes to financial losses.

"But, and that's why we are here," Rossouw stressed. "Don't see just one big black hole." Farmers have an extensive toolbox to help them cope with drought, but it is important to focus and find the correct balance.

Water management is crucial. Farmers need to work according to a water budget. The first step is to know how much water is available, taking evaporative losses into account. These can be up to a quarter of the water. Set up a detailed water budget. Measure water use weekly and adjust the figures if necessary.

As part of water budgeting, farmers must prioritize orchards according to economic potential and, if necessary, identify orchards for removal. This is a difficult decision, Rossouw told his audience. He cleared 24 hectares on his farm, so he knows.

Make every drop count for the remaining trees. Dig soil profiles in each orchard to determine root depths. Irrigate so that the water reaches the area of highest root concentration. Adjust the range of micro sprinklers from medium to short and irrigate at night. Tailor the irrigation schedule to the phenological stage of the trees. Monitor soil moisture at least twice a week using a probe as well as digging profiles. Give more water to the better orchards. Introduction of a short cooling cycle helps prevent sunburn. Remember to record all water use.

Rossouw put up a chart of fruit size over time. It showed that normal fruit development is achievable during drought. The key is careful water management. Mulch is an integral part of water conservation. Sandy soils need more mulch than clay. Rossouw uses wood chips and straw. In the past season he also tried growing oats during winter. When sprayed off in spring, the oats become mulch.

Rossouw emphasized that weeds compete with trees for water. Control weeds early. If weeds have grown large, make the most of a bad situation. Cut them down for mulch, unless they have already formed seeds.

Once the tree is fruiting, there are more hard decisions to make. Farmers must adjust the crop load to match irrigation levels. Aim for a ratio of one fruit to 25 leaves. Keep apples that are in ideal sites for color development and avoidance of sunburn.

Regular fruit measurements are important. Bigger fruit are better. Received wisdom is that one fruit per cluster is ideal. Rossouw recommends leaving two apples if both are large and remove a cluster with all small fruit instead.

Control the growth of the tree to limit water loss through transpiration. Use summer pruning or Regalis. Do this early or risk increased sunburn. Rossouw reminded farmers to adapt their fertilization programs. The needs of the tree will change due to drought management measures.

Drought management also extends to harvesting. Dry conditions may compromise fruit quality. Appropriate irrigation remains essential. Determine starch and sugar content of fruit. Make sure that enough pickers are available. Labor shortages lead to late harvesting, affecting quality during storage.

Now that your trees have looked after you in a challenging season, Rossouw said, you have to remember to look after them. Apply the correct post-harvest fertilization at the right time. Winter pruning matters more than ever. There is no place for unproductive wood or poor spurs on a tree. Rest breaking is important.

Lastly, Rossouw cautioned against chemical thinning. Trees that have suffered drought can have poor reserves and may not react as expected.

WATCH ROSSOUW'S PRESENTATION ON OUR YOUTUBE CHANNEL HERE.