# WATER SAVING TECHNOLOGIES
# FOR EMERGING AND SMALL SCALE FARMERS

WATER IS LIFE -
SANITATION IS DIGNITY

water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

# Foreword

Water is a precious resource, unfortunately it is also a limited resource. On earth, 97% of water is ocean water which is salty, 2% of the water is unfortunately frozen and only 1% of fresh water is available for human use. This already doesn't paint a good picture for our water resources as only 1% of water that is available needs to be shared between the Domestic sector (household/municipality), the agricultural sector, and the mining/ power/business sectors. South Africa is ranked the 34th water-scarce country in the world, with the agricultural sector in South Africa using the biggest share (about 60%) of water, with high water loses being estimated at between 30%-40%.

Agriculture is the practice and science of cultivating soil for growing crops to provide food, fibre, other commodities and products for people to purchase and consume. this sector is good because it ensures food security; people need to eat and not die of hunger. Irrigation is the essential activity within the agricultural sector. it is the only process – other than natural precipitation – that supplies water to crops, orchards, grass or any other cultivated plant (Stern, 1979). This process allows farmers to irrigate their crops even when there is no rain.

In South Africa we have commercial Irrigation schemes and small holding irrigation schemes. The Department of Agriculture, Forestry, Fisheries and the Environment states that approximately 1,5 million hectares (ha) is under irrigation (i.e.1,5% of the total agricultural land) of which about 50 000 ha are smallholder irrigation schemes (i.e. 3.3% of the total irrigated area). Details are obtainable on the following link:

https://www.nda.agric.za/doaDev/topMenu/DoAProgrammes/smallholder%20evaluation/Draft%20Business%20plan%20-0Part%201%20Irrigation%20Infrastructure%20amended%2017%20September2012.pdf

Therefore, it makes sense that the Agricultural sector uses about 60% of water, but the high water losses of 30-40% need to be scaled down hence the irrigation efficiency should be achieved.

In 2015/16, Directorate: Water Use Efficiency of the Department of Water and Sanitation initiated a project on conducting workshops about Water Conservation Water Demand Management (WCWDM) education and awareness targeting previously disadvantaged irrigation schemes. The workshops included presentation, discussions and excursion with identified irrigation schemes. However, the situation of irrigation schemes which

were visited was so dire as they were found to be out-dated and quite wasteful of water. Most of these irrigation schemes were still using flood irrigation. They had no idea of how much water is allocated, used and lost. Their infrastructure was old, had no maintenance plans and had deteriorated to an extent of resulting in high distribution losses.

During presentations and discussions, it was clear that the Department needed to do more on WCWDM education and awareness to assist the irrigation schemes towards achieving water use efficiency and thus decrease the level of high water loses.

The passion to do right and have water use efficient irrigation schemes is undoubtably existing. One of interventions the department has planned to introduce to the irrigation schemes is listing some of the existing technologies that could assist these schemes towards achieving water use efficiency. Therefore, this document on existing water saving technologies in the market was developed, with a view to promote water use efficiency on farms.

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# 1 Introduction

South Africa is a water-scarce country and thus all sectors are needed to ensure water conservation measures are implemented to save water. All well-established, emerging farmers and small scale farmers are urged to ensure essential water saving measures are implemented on their irrigation schemes and on farms.

Like in other sectors, water saving technologies can still be pursued to save water in the agricultural sector. Technologies are updated with time, and the more water efficient they are, the better for the agricultural sector. Water saving technologies must promote a 'drop per crop' technique when used.

This booklet is developed to create awareness on existing water technologies with a view to assist emerging and small scale farmers for their 'on the farm' water efficiency irrigation. These water saving technologies do not only focus on water efficient irrigation but also on overall productivity of the farm. Some of these technologies are available in the country, others globally. Farmers have liberty to conduct a research on the ones they are interested to implement on their farms. Further information regarding the implementation of these water saving technologies is available on the internet.

# 2 Water Saving technologies

## 2.1 Cellphones, smartphones and tablets apps

### Overview

The use of communication devices such as cellphones has become an important norm in these modern days. Applications (apps) have been developed on cellphones, smartphones and tablets to assist with almost everything in our everyday lives. On these devices, the agricultural sector can access monitoring apps used in the management of farms, including water management apps. These apps assist with assessing the weather and soil moisture, and thus alert the farmer to a need for irrigation. Farmers use these apps to schedule time for irrigating remotely and to calculate water metres used in irrigation. Cellphones, smartphones and tablets have proven to be invaluable devices for remote control of pivot irrigation.

The University of Nebraska has developed the following sectoral apps:

## The cellphone apps

- Water Meter Calculator: This app calculates how much water is used in a scheme for irrigation over a certain period, which then assists with water management in an irrigation scheme. Through the app, farmers know how much water is used in their schemes weekly, monthly and even annually (University of Nebraska: 2018).
- Crop Water: This cellphone app provides an easy way to monitor soil moisture. It can determine water status using watermark sensors installed at depths of 1 to 4 feet. The app is connected to the sensors, then the input of the sensor readings is sent to your phone. Once you receive these readings, you are then able to estimate how much water is used or present in the soil of your irrigation scheme. (University of Nebraska: 2018) https://extension.unl.edu/statewide/colfax/irrigationmanagement/

## Water Savings

Cellphone apps are important in the agricultural sector as they promote efficiency in irrigation management. Farmers can now save water by using water meter calculator and crop water apps. Farmers can now know how much water is used weekly, monthly or annually in their farms. This can assist with preventing over watering as the app also assists in calculating how much water is needed by a certain crop.

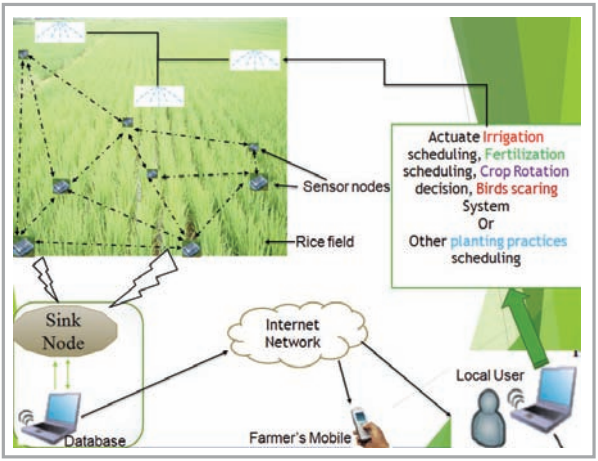



***Figure: 1 Water Saving Cellphones Apps use in agriculture***

# 3 Drones

## Overview

The agricultural sector requires technologies like agricultural drones that will provide farmers, service providers and agricultural researchers a fast and efficient way to monitor their crops, identify stress, create treatment plans, track plant growth, irrigation management and much more.

## Agricultural drones

A Drone is an unmanned aerial vehicle (UAV). It looks like a small aircraft without a human pilot on board, and it can fly over being controlled remotely by someone on the ground. This technology can be equipped with cameras, laser and GPS. Drones are not only used for leisure but can be used for several things as well, like in farms for water management. A drone can fly over farms and use its cameras to detect leaks, monitor irrigation and manage the soil moisture. Utilising the map of the irrigation scheme, a drone can fly over and check for visible leaks. Drones can also be fitted with sensors to sense invisible leaks as well as soil moisture. Irrigation experts say California farmers looking to save water will be early adopters of the drone technology, and not just to check for leaks. Drones can also, through the use of thermal cameras, help determine when crops are water-stressed or are getting too much water.

## Water Savings

A drone can assist a farmer to monitor large fields by flying over and capturing information needed by the farmer for efficient irrigation management. This also helps with cost saving as a need for hiring an intensive labour for the farm is less. It would take a farmworker more than a week to drive up and down the same large fields in an all-terrain vehicle. The drone can also assist in monitoring water leaks and the farmer can just go straight to a leak instead of wasting hours or days searching for it. Drones will help farmers get more information in real time and make better decisions about everything on the farm. https://www.kqed.org/science/16676/drones-the-newest-water-saving-tool-for-parched-farms

***Figure: 2 Drones used for water saving in the agricultural sector***

# 4 Advance sensor and satellite technology

## Overview

Advance Sensors and satellite technology are also used in the agricultural sector to achieve efficient irrigation management. Tools like soil moisture sensors are very important in achieving efficient irrigation management. Sensors and Satellite remote are used as a complementary source of information for monitoring and managing irrigation.

## Advance sensor and satellite technology

The advance sensor and satellite technology is the science of obtaining information about objects or areas from a distance. This technology collects data by detecting the energy reflected from Earth. It can also be used as a weather forecast tool for collecting weather data which can be used in favour of a farmer. In farming, the sensor and satellite technology assists with water saving.

These tools are used to collect data for irrigation purposes. The satellite can forecast weather changes and can also estimate when rain will come. This assists in switching off the irrigation system and preparing for water harvesting or letting the rain irrigate the farm. This information can be captured and sent to the farmer's cellphone or computer, who can then operate as he/she wishes.

## Water Savings

The advance sensor and satellite technology is therefore capable of providing critical information in support of managing water and monitoring irrigation. The farmer can now know when the rain would come and then when not to irrigate. The farmer would also know if the crops require watering or not.


***{Figure: 3 Advance sensor and satellite technologies used for water saving in the agricultural sector}***

# 5 Information system

## Overview

An information system in farms is important as it makes it easier for the farmer to account on how much water is used for irrigation and thus develop reports for regulation purposes. This gives a clear view of irrigation data, farm, irrigation methods used, and as well as to produce a report.

The preferred information system on water and agriculture should be able to collect data, analyse and disseminate data and information of a farm or irrigation scheme.

Data is important for an irrigation scheme. It flows between systems, databases and processes. It carries with it the ability to make the irrigation scheme smarter and more effective. This can assist the irrigation scheme to produce reports on the amount of water it uses and thus assist in improving its water use efficiency. With the information system in use, an irrigation scheme can produce monthly, quarterly, and annual reports. With these reports, a scheme can be able to showcase its pattern of water use over a period of time. This will lead to better decision making.

## 5.1 Water Administration System (WAS)

The Water Administration System (WAS) is a South African innovation and is a management tool for irrigation (i.e. it helps water managers to effectively measure and manage irrigation water). The Water Administration System (WAS) was designed as a management tool for irrigation schemes and water management officers wanting to manage their water accounts and water supply to users through canal networks, pipelines and rivers. (ARC, No. TT 465/10, October 2010)

WAS is an integrated, database-driven system with multiple water management capabilities structured as modules. These include handling any number of farmers, abstraction points and measuring stations on canal networks, pipelines and rivers. The system involves simplified and controlled ways of managing water allocations, use, distribution and billing. The seven modules include:

- Administration
- Water ordering
- Data measurement
- Water release
- Crop water use
- Accounts
- Report
- Dam information, and
- Bulk SMS.

These modules are integrated, making it possible to cross-reference relevant data and information. The system is designed to be installed either on a single computer or on a server for use over a network.

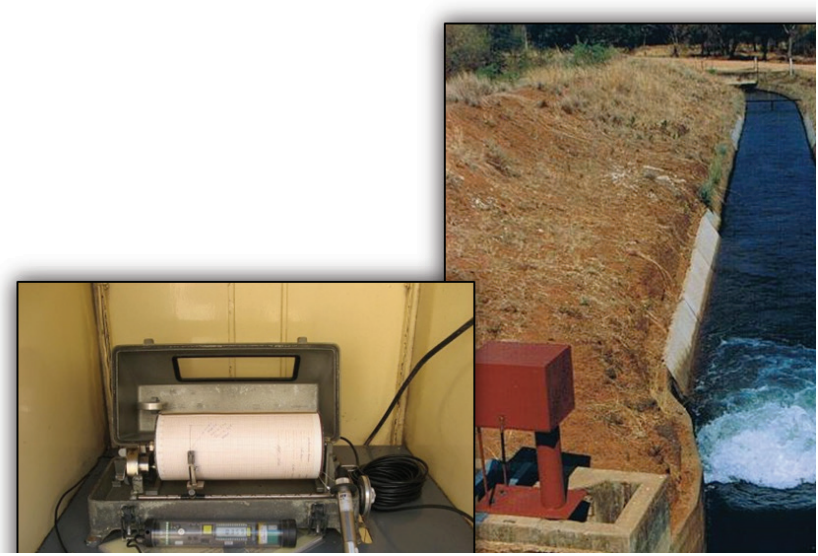


***Figure 5: Flow data collected via chart recorders and electronic loggers to be incorporated in the WAS***

## Water Savings

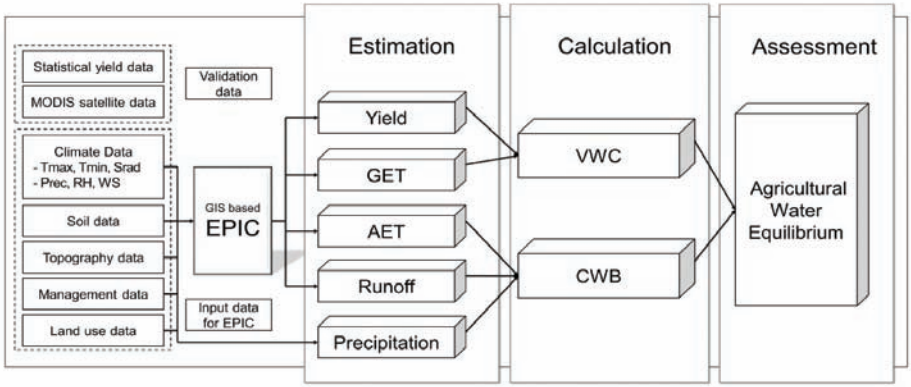
WAS achieves two key objectives for authorities:

- Firstly, it optimises the use of water on irrigation schemes. Ineffective water management on schemes results in water losses that could put the allocated water endowment at risk. It reduces water losses through a combination of water measurement and good administration.

  These water saving measures ensure that the right volume of water is delivered to each farmer accurately, on time and on a daily basis. Therefore, over the course of a season, dams are used more effectively (i.e. they remain fuller for longer). Alternatively, more water can be made available for use, either to expand the irrigation scheme or make more water available for non-irrigation uses. This safeguards the allocated water endowment for all water users.

- Secondly, it reduces direct and indirect water administration costs on irrigation schemes. The benefits include quality control, simplified management and operations, and sustainability due to reduction of dependence on individual capacity within WUA. The resultant administrative productivity benefits include reduced

operating costs, time saving, improved planning and improved transparency of water management for customers. WAS is a system designated for On Scheme level water management, however emerging and small scale farmers could use this, should they form an irrigation scheme.




***{Figure: 6 Water Information system as a water saving tool in the agricultural sector}***

# 6 Water management

## Overview

Agricultural water management includes the management of water used in crop production, both rain fed and the number of hectors within the irrigated land. Water management in the agriculture sector is to improve water use efficiency. This is to maximise crop per drop through irrigation and decrease water loss in the sector. Other elements of water management include soil management, water evaporation, rainfall, and irrigation system. One of the best tool used in water management is Water Metering.

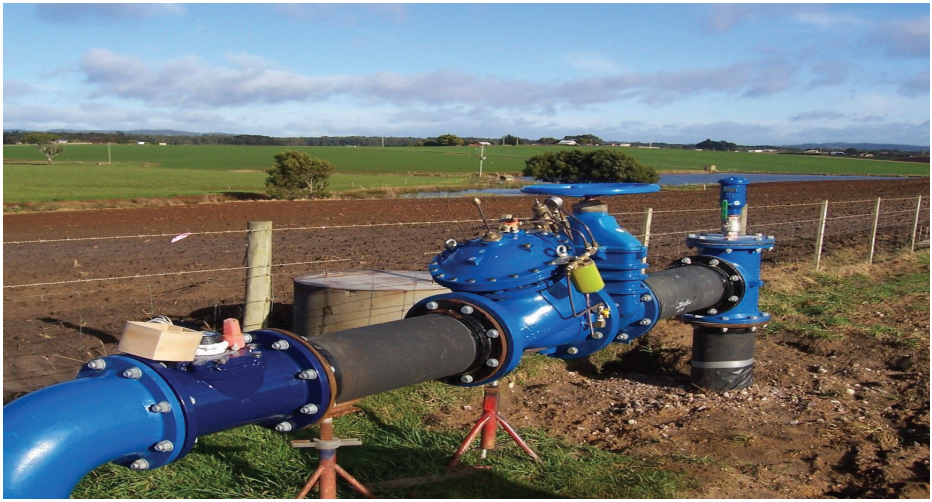
The proper management of water use requires an understanding of how much water is used by irrigation systems. On farm level, the installation of water meters is one tool farmers can use to optimise water use. In addition to benefits to farmers, the implementation of irrigation water measurement is encouraged by the National Water Act and the National Water Resource Strategy. New regulations for water measurement have been published.

## Water metering

Water Metering is essential as it increases water use efficiency. Metering of water use allows for maximum use of water. Additionally, water use pattern from the data allows for better crop-planning and decision making. Water metering promotes irrigation system performance and can also be used as a tool to monitor irrigation system performance. Water metering can assist with checking and confirming leaks within the irrigation schemes. Implementation of metering devices allows for more optimal management of irrigation systems. Section 26 (b) of the National Water Act allows the minister to require water use to be monitored, measured and recorded.

## Water Savings

Water metering helps the farmer to know how much water was allocated and used in the farm. This can also assist the farmer to know the water demand of his farm. Also the farmer can use the water meter to check for leaks in his farm. Water metering helps with achieving efficient irrigation management and saving of water.



***{Figure: 7 Water Metering as a tool to save water in the agricultural sector}***

# 7 Water Harvesting

## Overview

Precipitation is the major water source for agricultural production in a semi-arid region. It is important to capture as much rain during rainy season, which is to be used later when there are no rains as lack of rain often results in low crop yields and sometimes in total crop failure. Implementation of rainwater harvesting has been shown to successfully improve crop production and promote efficient water management in farms. Rainwater harvesting has great potential to achieve sustainable agriculture in semi-arid regions.

Many farmers rely on surface water (from dam, rivers etc.) and rain water or wells (ground water). Some have built their own ponds to capture and store rainfall for use throughout the year. Properly managed ponds can also create habitat for local wildlife. Use of rain water ponds can help minimise impact on the surrounding watershed. Others use rain water harvesting tanks to capture water and redirect them via irrigation system to their crops. The Department of Water and Sanitation has distributed rain water harvesting tanks throughout the country in 2020, in an effort to encourage farmers to use fed as an alternative source of water supply.

## Water harvesting ponds

Water harvesting ponds have great potential to improve agricultural water security through the capture, storage, and provision of water for irrigation. Ponds are filled by rainfall, as well as groundwater. The farmers can dig ponds and harvest water during rainy season to ensure water supply for irrigation when rainy season has stopped. Ponds can also be lined with clay soil. Clay is used as impervious material to reduce the amount of water that may soak into the ground. Water harvesting ponds can also supply water source like recharging groundwater, and provide a wide range of additional economic and environmental benefits.

***Figure: 8.1 Water Harvesting. A dam water storage is one of water saving techniques in the agricultural sector***

***Figure: 8.2 Rainwater harvesting tanks***

Rainwater harvesting tanks can be used by a farmer to harvest rain water during rainy season, store it and later irrigate crops during dry season. Mostly, farmers with standing structures can connect rain gutters on the roof of the structure connecting to a tank or tanks. This will help the famer from running out of water during a dry season and will cut cost from paying for more water needed for irrigation.

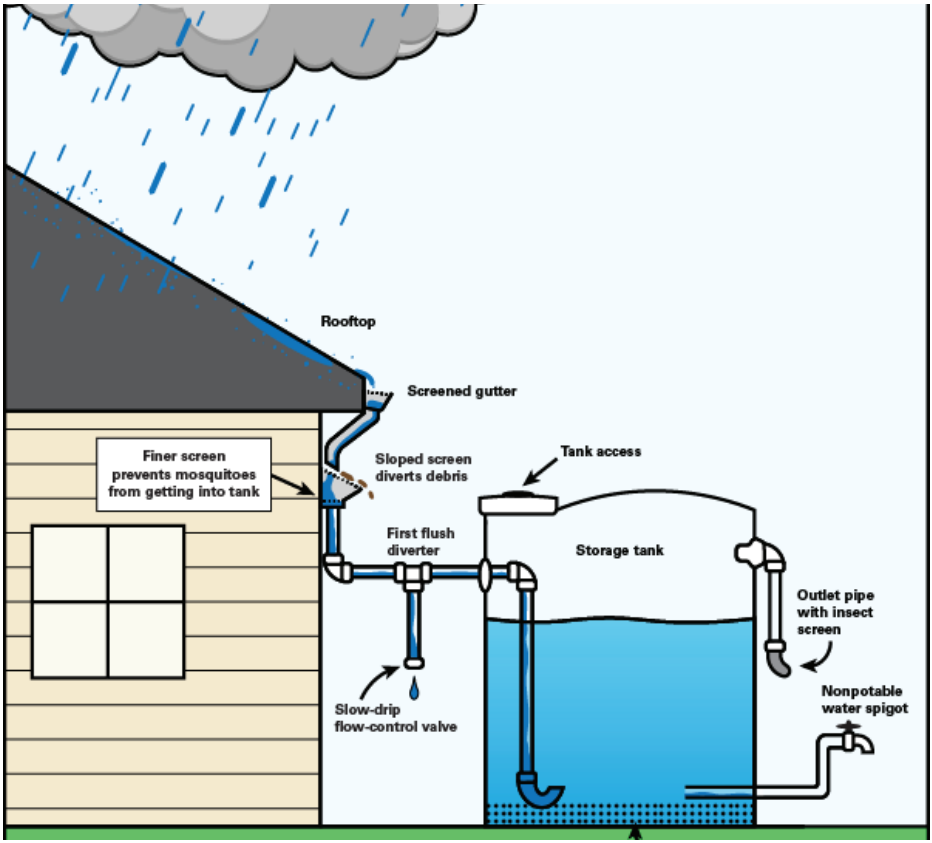



***Figure: 8.3 Water harvesting tanks used for irrigation***

## Water Savings

During rainy season, there's lots of water available which is currently not needed for irrigation. Rain water harvesting is important as it is about capturing rain water which can be stored for a dry season. The water can be captured using roof, gutters and tanks, or simply by digging water ponds. This also saves the farmer from paying more cost for water to irrigate crops.

# 8 Water recycling on farms

## Overview

Both surface water and groundwater is not enough due to high demand of water in the agricultural sector, therefore it is important to look at recycling the water as a substitute. The municipal and agricultural water recycling method is most popular in the agricultural sector for irrigation management. When it comes to water recycling for irrigation. Water quality requirements are essential especially for each type of crop (i.e. those eaten raw, those receiving processing before consumption and those not involving any human contact before industrial processing.

Water loss in Agricultural is very high, about 30%-40% in South Africa. When the surface irrigation method is used, there will be water runoffs. If not managed efficiently, water runoffs can easily increase water loss in the agricultural sector. In reducing water loss, farmers will have to explore more on reducing agricultural wastewater by implementing agricultural water recycling.

## Municipal water recycles

Agricultural water reuse can provide sustainable access to water. This method has been rediscovered as an important opportunity for sustainability, conservation and cost-reduction. However, there are guidelines that need to be followed for protection of consumers of the agricultural products and farm workers who may come into contact with recycled waste and solids. Water reuse in agriculture is an option but it needs to be implemented correctly so that crops and humans are not exposed to danger.

Principal health concerns primarily involve the necessity of having sufficient treatment processes for elimination of pathogenic micro-organisms in water and bio-solids and for preventing accumulation of pesticides, non-biodegradable commercial, industrial chemicals and drug residues that could be in the waste and then become accessible for uptake by food crops.

The World Health Organization (WHO) guidelines are described as reasonable minimum requirements of good practice but they are not mandatory limits. The WHO provides guidance and then defers to national governments to determine if and how this guidance will be applied.

## Agricultural water recycles

An agricultural water recycle is the excess water that runs off the field at the low end of furrows, border strips, basins, and flooded areas during surface irrigation. Ensuring that farmers capture the certain amount of water runoffs and recycle the water for irrigation will promote water use efficiency.

The water captured in the agricultural water recycle contains too much salt and nutrients to be used safely for irrigation of fields, therefore the mixing with lower-salinity source water can solve or reduce this problem. Balance the nutrients and increase the quantity.

Water Savings

Water savings achieved by using recycled water can range up to 100 percent of the demand, depending on the extent to which available recycled water must be supplemented with traditional sources of irrigation water. In some cases, river water or well water is supplemented with recycled water to produce a blend with a lower salinity than that of straight recycled water. There is significant opportunity to substantially expand the use of recycled water for agricultural irrigation.

Where surface irrigation methods are in use, the savings in irrigation water volume can range from a few to over 50% - depending on field slope, uniformity of topography, design of the fields, and manual and mechanical control mechanisms used on the farm.

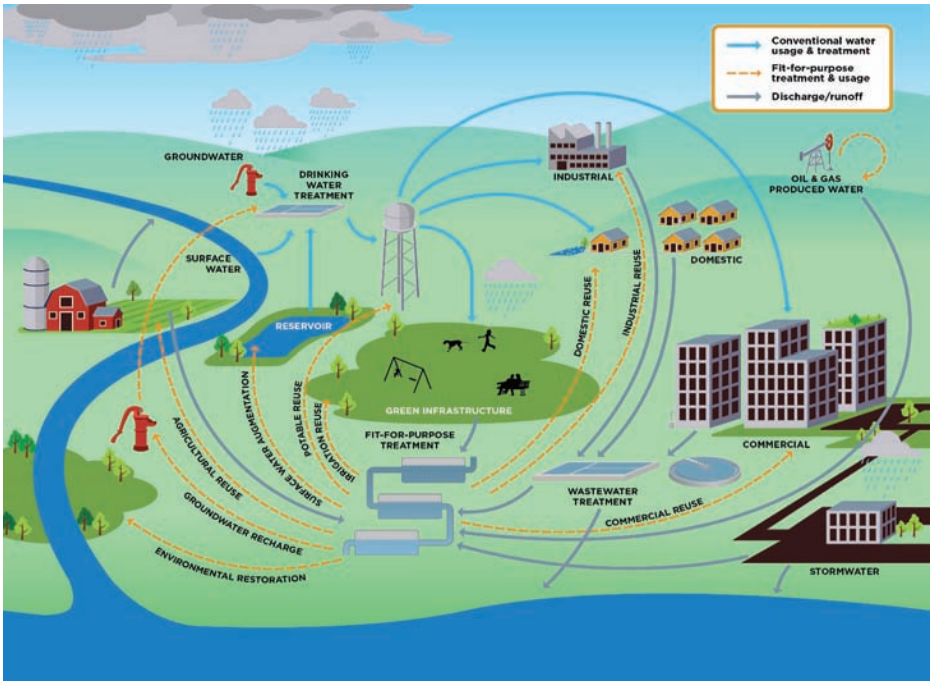



***Figure: 9 Water recycling as a technique to save water in the agricultural sector***

# 9 Green House Farming

## Overview

Green house is a house used to grow crops, where a farmer can mimic a climate, season or set a preferred temperature for crops planted. Green houses are good in saving water as well as space, because farmers can even plant their crops vertically. Some even uses hydroponic, using water to grow plants instead of soil.

## Greenhouse farming

Greenhouse farming saves water as a result of reduced water loss through evapotranspiration, the precise water application of drip irrigation, the concentration of crop root zones in closer crop spacing, and the reduced length of a crop cycle. Greenhouses are built in a way that crops can be planted in a furrow, vertically. Most common irrigation method used for greenhouse

farming is drip irrigation. Only the root zone of the crop is given water. The covering of the greenhouse is essential for evapotranspiration and minimising evaporation. Farmers can create their greenhouses using materials that maximise the heat from the sun.

## Water Savings

The greenhouse water savings come from evapotranspiration and reduced evaporation rate inside of the greenhouse. Greenhouses potentially save water as compared to an open-air crop field.

***Figure: 10 Green house as a technique to save water in the agricultural sector***

# 10 Reel gardening

## Overview

Reel gardening is one of the projects that took centre stage at the South African Youth Water Prize competition organised by the Department Water and Sanitation in 2003. Through this project, South Africa assumed position 1 at the Stockholm Junior Water Prize held in Sweden in 2003. The learner who represented South Africa in the international competition was Claire Reed.

Reel gardening

Reel gardening is a biodegradable seed with nutrients. The seed tape can be planted straight into the soil. The tape contains high quality, non-chemical treated seed. The seeds are held within the tape at the correct depth and distanced apart for the plant to grow. Using the tape makes the starting of the vegetable gardening easy. This reel gardening can save about 80% of water. https://reelgardening.co.za/how-it-works-2/ The Reel gardening also has a cellphone app.


***Figure 11: A Reel Gardening technique saves water by about 80%***

## Water Saving

The Reel Gardening saves about 80% of water than a conservative farming. the strip of the seed tape is placed in the soil and the tape makes it easy for you to see where the plant is germinating and growing. You need to water daily, but not soak the seed tape, just enough to moisture the tape. That is how you save 80% of water.

# 11 Nocturnal Hydro Minimiser

## Overview

This project is also one of projects that saw South Africa win at the Stockholm Junior Water Prize in 2005. Learners who represented South Africa in Stockholm were Matobele Motshodi, Sechaba Ramabenyane and Pontsho Moletsane.

## Nocturnal Hydro Minimiser

The 2005 winners took the prize through an invention, which they call the "NOCTURNAL HYDRO MINIMISER". South Africa has very low annual rainfalls, which results in water scarcity. Evaporation is also very high because of a very hot climate resulting in losses of the limited water resources during the day. With limited water resources for irrigation more stress is caused for the agricultural sector. The three learners developed a low cost revolutionary solution called the Nocturnal Hydro Minimiser. The system is designed to use water efficiently for irrigation purposes by activating the water tap at night when evaporation levels are very low. It ensures that crops are only watered when the soil has lost the necessary moisture needed by plants. This feature is more effective in saving water compared to other existing models that provide water regardless of whether plants need it or not. The Nocturnal Hydro Minimiser has great potential to improve irrigation in the agricultural sector.

## Water Savings

The Nocturnal Hydro saves water by minimising evaporation and watering crops when the soil has lost necessary moisture needed by crops. Also irrigating at night than irrigating during the day when it is hot will promote less to none water lost via evaporation. This will assist the farmer to efficiently irrigate his/her farm.

# 12 Irrigation Systems

## Overview

Water quantity is a major concern especially in water scarce countries. The amount of water available for irrigation is crucial for irrigation management. Water quantity has emerged as a leading consideration in managing irrigation. Irrigation systems have to be managed so that the amount of applied water closely matches crop water requirements. Poorly managed irrigation systems can cause soil damage, environmental problems, and contribute to low water use efficiency. Agricultural sector need to ensure water use efficiency as water is scarce and having a good irrigation management is essential. Irrigation management has evolved in practices and technologies, today we have a number of irrigation systems to ensure water efficiency in irrigation management.

The irrigation management or system is one of the most important ways of saving water. On a farm, the biggest water saving contribution is derived from the irrigation system that is used by the farmer or the irrigation scheme. There are several irrigation systems that can be used by farmers however, there are few that are regarded as water efficient irrigation systems. In South Africa we use different irrigation systems.

## 12.1 Drip irrigation system

A dripper is a small device that consists of a small inlet, a very small flow path that reduces the flow and pressure in the dripper, and an outlet that delivers a certain amount of litres per hour according to the rating of the specific dripper. Drip irrigation uses drip emitters that slowly apply water to crop root zones. Drip irrigation usually consists of a pressurized tubing system that is run along crop rows. These tubes are fitted with emission devices at specific distances to allow water to drip from the emitters.

Drip irrigation is developed with the primary aim of saving water. It originated in the 1960s in Israel where arid climatic conditions, sandy soil types and critical lack of water availability cause sprinkler irrigation to be highly ineffective and costly due to high evaporation losses. When holes are simply made in a pipe, the water will spray out according to the size of the hole and the water pressure. Drip irrigation systems deliver water directly to a plant's roots, reducing the evaporation that happens with spray watering systems. Timers can be used to schedule watering for the cooler parts of the day, further reducing water loss. Properly installed drip irrigation systems can save up to 95% more water than conventional irrigation, and can even contribute to increased crop yields.

***Figure: 12. Drip irrigation method saving water in the agricultural sector***

***Figure: 13. Drippers***

## 12.2 Sprinkler irrigation System

A **sprinkler system** delivers water under pressure with the assistance of sprinklers that spray the water over a certain area. The wetting pattern of each sprinkler is usually a circle, and the design of a sprinkler system makes provision for the circles overlapping to create an equal water distribution over the area. Sprinklers are one of the mostly used irrigation systems in South Africa. Sprinkler system is also regarded as one of the water efficient irrigation systems after the drip irrigation. There are different types of sprinkler irrigation systems that can be used by farmers or irrigation schemes. The different types of sprinkler irrigation systems are Micro, Permanent and movable sprinkler systems.

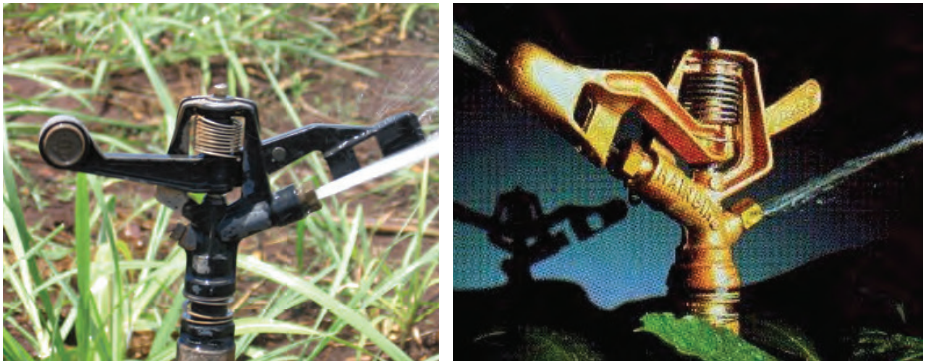


***Figure: 14. Impact sprinklers***

***Figure: 15. Floppy irrigation system***

***Figure: 16. Dragline system***

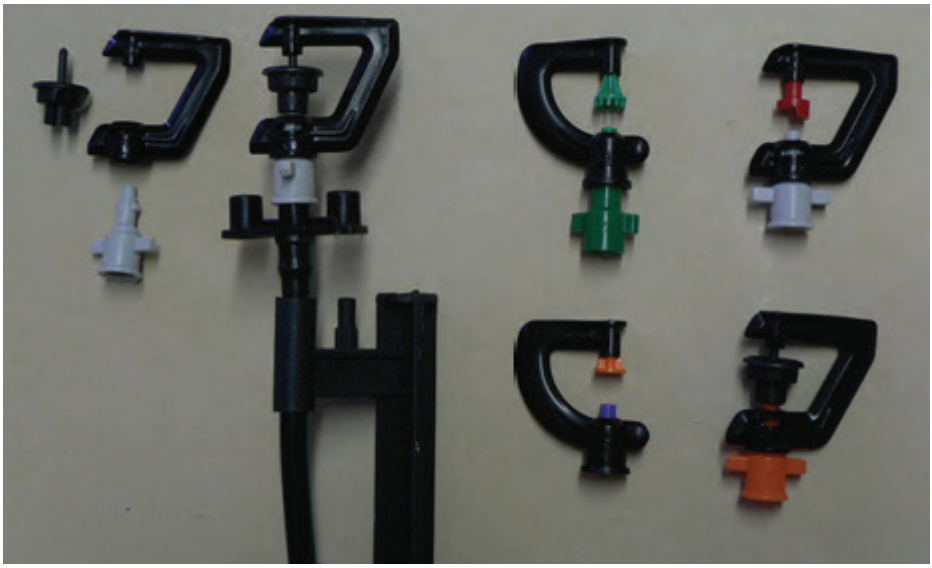


***Figure: 17. Micro sprinklers under trees and examples of different types***

## 12.3 Centre pivot irrigation system

Centre pivot technology is used on large fields with soils having relatively high infiltration rates. Centre pivots are commonly used on row crops and vegetables. The centre pivot is a centre piece which supplies water for irrigation. It has a number of spans housing the sprinklers. A span is a steel structure supporting the supply pipe to which the sprinklers are connected. At the end of each span is a set of two electrically driven wheels which drive the span to rotate (pivot) around the centre piece. Sprinkler heads can be lowered to just inches above the tops of the plants, which minimises water loss from evaporation and wind drift. The technology is both labour and water efficient. The centre pivot irrigation system is regarded as one of irrigation system that are water efficient.

.

***Figure: 1. Centre pivot in line***

Soil moisture monitoring and irrigation scheduling

| PROGRAMME | WATER DAYS | START TIMES | VALVE NO | LOCATION | VALVE RUN TIME |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
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***Figure: 19. Irrigation scheduling***

Soil moisture and irrigation scheduling helps farmers to accurately predict the timing and amount of irrigation water. There are a variety of methods for determining when and how much to irrigate crops. Monitoring of soil moisture levels to help determine when to irrigate can lead to water use efficiency and thus maximising yields. There are different methods of monitoring the soil moisture and lots of technologies available in the market to monitor soil moisture. Combining soil moisture monitoring with a method of irrigation scheduling can produce multiple benefits.

In irrigation scheduling, factors like water per crop requirements are assessed to get the efficient irrigation scheduling management. There are various techniques and software programs readily available for farmers to utilize developing irrigation schedules. Smart water management is not just about how water is delivered but also when, how often, and how much. To avoid under- or overwatering their crops, farmers carefully monitor the weather forecast, as well as soil and plant moisture, and adapt their irrigation schedule to the current conditions. One method of irrigation scheduling relies on actual weather data in conjunction with crop coefficients to estimate crop water demand.

Some technologies used for soil moisture and irrigation scheduling are: soil moisture sensors, automated irrigation controls. Irrigation systems can be controlled manually or be automated. Recent technological developments include the use of sensors and controls to manage irrigation systems. Automated irrigation systems use weather station data and/or moisture sensor data to determine when and for how long to irrigate crops. Sensors are placed into the ground to monitor soil moisture and connected to a control system, which can be a computer or a cellphone. The control system can use real-time data from the sensor or a combination of inputs to determine irrigation timing and amount of water to irrigate crops. The sensor tells the computer how much moisture there is in the soil, which determines if water is required or not or how much time can go still without irrigating the crops. Incorporating soil moisture sensors into an irrigation system is an important tool for water conservation.

## Water Savings

The country facing water scarcity and the agricultural sector having 30%-40% of water losses, the above mentioned water irrigation methods and technologies assist in saving water and improving irrigation management. The methods and applications mentioned above are just a few irrigation management practices that are being practiced today. The basis of irrigation scheduling is to determine the amount of water to apply to a field and when to apply it. Knowing how what crops the farmer is growing and how much water the crops requires is also essential in knowing when and how much water the crop needs. Assessing soil moisture is also essential in knowing when to or not to irrigate, in that way no water wastage. In drip irrigation, water is slowly but directly applied to the plant root zone. Water is not wasted on non-growth areas and the plant root zone is maintained at its ideal moisture level when properly scheduled. Drip irrigation can maintain an optimum moisture level in the soil at all times with less water lost to the sun and the wind. Drip irrigation can optimize applied water used on crops and orchards.

Subsurface drip further reduces the loss of water due to evaporation and/or wind. Subsurface drip irrigation does not typically wet the soil surface, so weeds do no germinate. Regulated deficit irrigation has been shown to reduce additional water use. Using the above technologies and methodologies in conjunction can increase total water savings.

## 13 Bonus water saving tips on farms

- **Use of mulch/ crop residue**: It can save up to 20% of irrigation water requirements – through reduced evaporation rate
- **Lining of canals**: Canal lining is the process of reducing seepage loss of irrigation water by adding an impermeable layer to the edges of the trench. Seepage can result in losses of 30 to 50 % of irrigation water from canals, so adding lining can make irrigation systems more efficient. Even though this technique will not completely eliminate losses, but roughly 60 to 80% of the water that is lost in unlined irrigation canals can be saved.
- **Installation of Shade nets**: Shade nets are considered an intermediate solution for increasing water use efficiency and reducing plant water stress. These nets offer a number of advantages and environmental benefits like: - a reduced wind speed, help decrease fruit dropping, improve fruit quality (as they protect against less hail, wind & sun damage). Shade offered does not affect the yield and internal fruit quality but may increase average weight and diameter of the fruit.
- **Repair, upgrade and maintenance** of irrigation systems and repairing of leaks and damaged/ cracked irrigation infrastructure will save volumes of water.
- **Conservation agriculture methods**: - reducing evapotranspiration, no till and other methods – these will go an extra mile in saving water.
- **Good weed control**: weed uses a lot of water. Controlling weed and constantly removing alien vegetation will save volumes of water.
- **Irrigation in the early morning or late afternoon** will reduce evapotranspiration.
- **Use of good cultivars**, high yields versus low water use. Substitute crops with drought tolerant crops
- **Consideration of water footprint** for export products will improve water efficiency.

# 14 Conclusion

The agricultural sector uses most of available water. Therefore, it is essential that the sector always seeks means of saving water through irrigation management, soil management, distribution of water, *etc*. Technology assists us as we improve our daily lives, targeting to achieve more than most conventional ways. Technology in agriculture improves water distribution, irrigation management, soil management towards ensuring that the farmer's yield of produce is more productive.

Water saving technologies improve efficiency in irrigation, ensuring that there is more crop per drop. Technologies also equip the farmer with the better management skills, when some of the technologies are used a farmer can get data, analyse data and use that information for better management of the farm. Water saving technologies also decrease water wastage, recycle and reuse of water. The use of water saving technologies will improve water use efficiency on farms, better soil management and ensure productivity.

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