Celebrating the development of irrigation technologies

By using water wisely, we are always ready to celebrate irrigation technologies. From the ancient irrigation system Dujiangyan in China that was originally constructed around 256 BC as an irrigation and flood control project and that is still in use today to the modern day irrigation technologies of drip and centre pivots, the landscape in irrigated agriculture changed tremendously.

In South Africa, the first centre pivot was launched in September 1970 at Soetvelde Farm near Vereeniging, which celebrates 50 years of the centre pivot in South Africa. Drip irrigation was also introduced to South Africa in the late seventies that also celebrates more than 50 years of modern drip irrigation.

Importance of irrigation
Although irrigated agriculture uses 62% of the available water resources in South Africa, the importance of this sector for the economy and food security is undisputed. Irrigation supports approximately 25 to 30% of national agricultural production. It is estimated that up to 90% of irrigated areas are planted with high-value crops (e.g. potatoes, vegetables, grapes and other fruit and tobacco), of which 25 to 40% are industrial crops such as sugarcane and cotton.

In the world, the agricultural sector is by far the biggest user of water and account for 70% of the world's total water withdrawal. In Africa and Asia, it is 85-90% of all the freshwater used is for agriculture. Now 300 million hectares are irrigated which is about 19% of the world's cultivated lands and it accounts for almost half of the value of global crop production. The world's population tripled in the twentieth century (there are now more than 7 billion humans on earth), and irrigation play a vital role to enhance the worldwide supply of food and fibre for all people.
Irrigation Systems
The purpose of an irrigation system is to apply the desired amount of water, at the correct application rate and uniformly to the whole field, at the right time, with the least amount of non-beneficial water consumption (losses), and as economically as possible. Irrigation systems in use are classified as follows:

- flood or gravity irrigation systems by which water that flows under gravitation is applied to the farmlands. This includes basin, border, furrow, short furrow, and contour irrigation.
- mobile irrigation systems, which move over the farmland under its own power while it irrigates. This includes centre pivot, linear, travelling gun, systems.
- static irrigation systems:
  - sprinkler irrigation systems, which are moved mechanically or manually from one position to another, to irrigate the entire farmland surface. This includes quick couple, dragline, hop-along, big gun, side-roll, and irrigating boom systems.
  - micro irrigation systems, which are permanent after installation and not normally moved. This includes micro and drip systems.

The utilisation tendencies of the different irrigation methods in South Africa are shown graphically in Figure 1.

![Irrigation development in South Africa](image)

**Figure 1: Projection of utilisation tendencies of different irrigation methods in South Africa**

Development of irrigation technologies
Irrigation system development and research over many years on the techniques of flood-, mobile- and irrigation contributed tremendously to the knowledge base of applying irrigation methods correctly.

The development of irrigation equipment contributed to the advancement of irrigation in the world and sprinkler irrigation begun around the 19th century in Germany, Italy, the USA, and Russia. The first generation of sprinkler appeared in 1917, but until 1920 the application was limited to watering vegetables crops and orchards. The initial use of sprinkler irrigation was the fixed sprinkler systems. Rotating sprinklers developed by USA, England, France, Germany, and Italy emerged gradually after the 1930s. After World War 2, towed, movable, centre-pivot, reel traction,
self-propelled and other large and medium-sized sprinklers emerged, so that sprinkler irrigation technologies developed rapidly all over the world. Some innovations that contributed to the advancement of irrigation in the world are:

- Sprinkler irrigation first became a reality at the end of the 19th century. In 1894, Charles Skinner, a farmer from Troy, Ohio, was issued a patent for a sprinkling system. It came to be known as the "Skinner System".
- In 1933 Orton Englehart invented the first impact sprinkler to water his orange orchards in Glendora, California.
- In the late 1940s, after World War II, rotating impact sprinklers with portable aluminium and light gauge steel pipes found their way to worldwide markets.
- In July 1949, Frank Zybach from Nebraska applied for a patent on his "Zybach Self-Propelled Sprinkling Apparatus". He did not know it at the time, but in the decades that followed, his apparatus would become the centre pivot irrigation system. It revolutionized farming in the USA and was exported to agricultural operations around the world.
- In 1959, a new technology of drip irrigation was introduced in Israel by Simcha Blass and his son Yeshayahu, where they developed and patented the first practical surface drip irrigation emitter.
- The Micro-sprayer concept was developed in South Africa to contain the dust on mine heaps. From here, much more advanced developments took place to use it as a method to apply water to mainly agricultural crops.

According to AQUASTAT – the largest online database of the Food and Agricultural Organisation on water, over 324Mha are equipped for irrigation worldwide, of which about 85% or 275Mha are irrigated. Many countries in Asia, North Africa, Near East, Western Europe, North and South America irrigated area is up to 50% or more of the total cultivated area. This means that potential for expansion of the irrigated areas in these countries and regions is extremely limited.

New products and emerging technologies

Over the past number of years, innovations in agriculture technology (precision agricultural innovations, data analytics and processing, platforms for the collection and distribution of complex data streams, and IT driven extensions) have been on the rise. Using these technologies along the entire agriculture value chain, the world can increase the productivity of its farming systems, while simultaneously transforming agriculture into a source of environmental health.

New innovative and emerging technologies or
solutions in irrigation to name but a few can be grouped into three main categories:

- **Augmenting and improving water supply:**
  - solar and wind as source of alternative energy.
  - operating algorithms to control and manage water productivity from dam water release to root zone application.
  - an integrated water administration system with an information management system for irrigation schemes that deliver water on demand through canal networks and rivers.

- **Improving water productivity:**
  - pivot-drip that combines efficiency of surface drip irrigation with the flexibility and economics of mechanized irrigation systems.
  - pivoted sprinklers to improve the water distributions in a crop field by managing crop evapotranspiration, which is influenced by factors like type of crop, method of irrigation, climate, and condition of the soil.
  - integrated sensors to monitor soil and plant contained by a wireless communication system that gives inputs for algorithms to control and manage the irrigation systems.
  - applying micro-irrigation, as it still constitutes an emerging technology in some regions. Micro-irrigation is only 6% (19 Mha) of the amount of irrigated land in 2020 and it continues to grow.
  - irrigation utilizing ultra-low-flow (0.4 ℓ/h) compensated drip lines.

- low flow spray/micro-sprinkler irrigation.
- application of drone technology as a source of valuable information about when and where to apply precise quantities of water to the crop.
- remote sensing coupled with the Internet and mobile communications.

- **Managing water demand and maintaining irrigation systems:**
  - utilising a wetting front detector for precision water application.
  - smart irrigation technology that promotes healthy and attractive irrigation by improving watering efficiency with new Smart technologies such as smart irrigation controllers.
  - innovative technology that uses ultrasonic sound to clean drip pipes to embrace the efficiencies offered by drip irrigation to preserve precious water resources and to get a return on the investment.
  - improving operation and maintenance of irrigation systems using farmland GIS.

**Summary**
We must celebrate irrigation technologies everyday by using water wisely and be water smart.

Applying water correctly at the right time, with the least amount of non-beneficial water consumption and as economically as possible with the correct irrigation technologies is very important to adapt to a variable and changing climate and emerging irrigation technologies together with existing technologies is expected to play a much bigger role in future.