LIFE CLINOMICS

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Irrigation and good water-saving practices

Irrigation is and has for some time been the driving force behind agricultural development in many parts of Catalonia, leading to complementary activities that boost the local economy and ultimately encourage settlement in the area – improvements which have an impact on society itself.

From the point of view of infrastructures, irrigation canals play a greater role than that strictly related to irrigation as they are also used to cover water requirements for domestic, industrial and leisure use.

The aim of irrigation is to supply crops with sufficient water to be able to produce food for human consumption (fruit, vegetables and cereals) and for livestock farming (animal feed and fodder). Other types of production can also be seen such as aromatic and medicinal plants, flowers and ornamental plants, and some products for industrial applications like wood, fuels, etc.

Irrigation enables production to be increased, the quality of the crops to be improved and species to be grown that would not be viable without an additional supply of water. Irrigation is applied in different ways depending on the type of production aimed for.

Optimised irrigation requires knowledge of production factors. It is necessary to know the periods during the growing cycle in which the water supply will have a direct effect on the final yield. This approach not only enables us to know at what point water is the most limiting factor in terms of achieving the best yield, but it even enables us to draw up a plant growth model and reduce water consumption.

MAIN PURPOSES OF IRRIGATION

- To provide the water required to grow crops
- To prevent the concentration of salts in the soil
- To prevent crops from freezing
- To transport nutrients and pesticides

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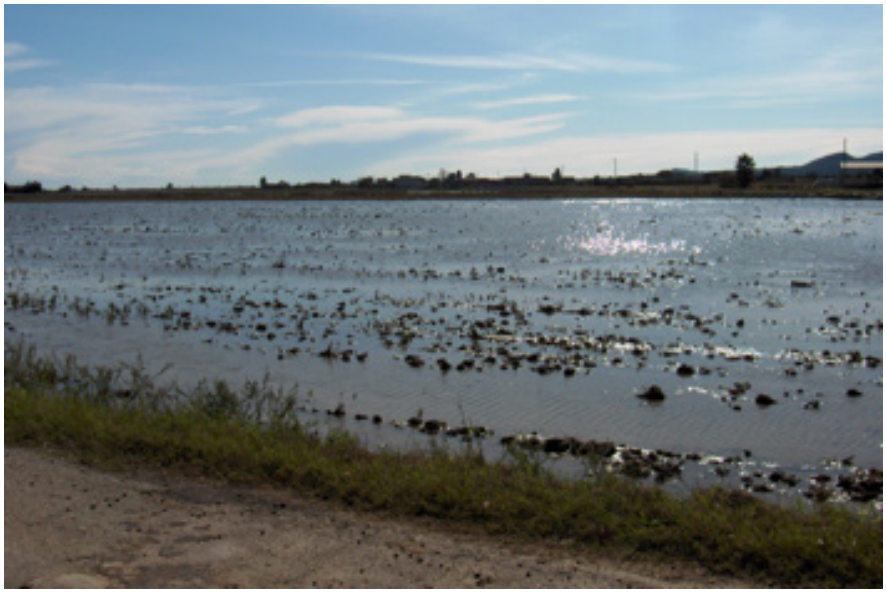
IRRIGATION SYSTEMS

Gravity-fed irrigation

Gravity-fed or surface irrigation is the oldest system. It is based on the movement of the water across the ground due to a slight difference in the level of the land. Therefore, the best areas in which to apply gravity-fed irrigation is flatter land with gentle slopes. The most common gravity-fed irrigation systems are basin irrigation and furrow irrigation.

Compared to other irrigation systems, gravity-fed irrigation can lead to lower application efficiency values given that it requires the irrigation parameters to be more finely calibrated. This may mean an increase in the volume of water applied per unit area or unit of crop, with a higher proportion of water that will not be used for the crop and that will drain into deeper layers in the ground and may end up recharging the aquifers.

It is currently thought that gravity-fed irrigation is used on more than half of the irrigated land in Catalonia.



LIST OF GOOD PRACTICES IN GRAVITY-FED IRRIGATION

DESIGN PARAMETERS

- Slope, texture and uniformity
- Irrigation time
- Speed at which the water moves

CONTROL PARAMETERS

- Monitoring the level of the water coverage at the lowest point
- Monitoring the infiltration time on the plot

ADVANTAGES	DISADVANTAGES
No costly installations are required on the land.	Variability of the water infiltration.
Enables the use of poor-quality water, although not saltwater.	Requires the land to be well levelled, which may entail high costs.
Lower installation and maintenance costs.	The irrigation strongly conditions the rest of the work.
Suitable for salt washing.	Requires a great deal of labour.
The irrigation is scarcely affected by the weather.	Requires a specialised workforce.
No external power supply required to apply the water.	Difficult to carry out brief, frequent irrigation.

IRRIGATION SYSTEMS

Sprinkler irrigation

Sprinkler irrigation is a widely used system which applies water to the entire ground surface in a similar way to rain. This is a system which can be used in many different ways, enabling light irrigation when the crop requires it during the early stages and abundant irrigation in periods of greater demand. It is also a system which is used in the fight against freezing, as the continuous formation of ice on the leafy parts of the crop allows for a safety margin when faced with a drop in temperatures to below freezing point.

Sprinkler irrigation systems are highly versatile: they enable highly diverse mobile or fixed systems to be installed but with the common feature of the sprinkler. This is the last element in the irrigation water distribution process. The sprinkler is one of the most important elements to take into account in order to irrigate correctly and evenly. It is of utmost importance to check its main features: the sprinkler height, type, quality, distribution, flow and pressure.

Currently in Catalonia the proportion of irrigated land covered by sprinkler irrigation is 10%.

LIST OF GOOD PRACTICES IN SPRINKLER IRRIGATION

- Do not irrigate in high winds
- Avoid irrigation when the sun is at its strongest
- Work at a suitable pressure and control the uniformity of the irrigation
- Monitor the difference at the filtration system inlet and outlet
- Regularly check the cleanliness of filters and risers
- Check the state of the crop vegetation
- Monitor the salinity of the irrigation water

ADVANTAGES

- Less labour is required. The system does not need to be manned for as long and is easy to use.
- The system can be automated.
- Applications adjusted to the needs of the crops or ground types.
- The evenness of the application does not depend on the characteristics of the ground.
- Can be adapted to most crops. Enables crops to be divided into plots during irrigation as each area can be watered as necessary.
- Enables nocturnal irrigation.
- Possibility to complement mobile irrigation systems with fixed systems.
- Can be adapted to the shape and lay of the land.

DISADVANTAGES

- The installations can be a physical impediment when carrying out some tasks on the crop.
- Irrigation control is limited by atmospheric conditions.
- IHigh investment cost, usually higher than other irrigation systems.
- Some sprinkler irrigation systems require higher working pressures and therefore also need pipes with a greater diameter.

IRRIGATION SYSTEMS

Drip irrigation

Drip irrigation is based on the irrigation of certain points of the plant root system. This enables loss by evaporation to be minimised as it only wets part of the ground. This system is the most suitable for applying fertiliser together with the irrigation water or soil correctors. This is the ideal system for crops in which the parts exposed to the air are sensitive to moisture (such as fruit trees). This enables small doses to be applied, making it useful for support irrigation.

Drip irrigation in Catalonia is estimated to account for 32% of the irrigated land, the most widely used system being the pressurised irrigation system. It is expected that this will increase in coming years due to its water-saving efficiency compared to other irrigation systems.

LIST OF GOOD PRACTICES IN DRIP IRRIGATION

- Ensure that there is an effective filtering system in place to avoid blockages
- Monitor the pressure difference at the filtration system inlet and outlet
- Monitor the uniformity of the irrigation with flow and pressure tests on some drippers
- Check the state of the crop vegetation
- Regularly check the cleanliness of filters and dripper lines
- Regularly check that the emitters are correctly placed

ADVANTAGES

- More efficient use of water and nutrients.
- Can be applied to a wide range of land types.
- Provides solutions on rugged terrain. Does not require terraces.
- Better pesticide control.
- Enables water with a high level of salinity to be used.
- Reduces staffing problems; if irrigation is automated, there is practically no human intervention.
- Enables the use of soluble fertilisers in the irrigation water.
- Permanent, automatic system.
- Water loss by evaporation is reduced.
- It saves water as there is no need to water the whole area of land.
- It interferes little or very little with other agricultural practices.
- Precise water distribution and application flexibility.
- The water is directly available at the root.
- Not affected by wind intensity.

DISADVANTAGES

- High initial investment, thus requiring financial analysis of the crop.
- The installations need to be designed and assembled by highly specialised staff.
- Quality control of materials used.
- Requires farmers to be more specialised.
- System maintenance and handling are particularly important to ensure that it is working properly.
- The demands of the filtration system are very strict. The system must be cleaned thoroughly.
- Problems may arise from damage caused by animals.
- It is difficult to detect damage to the irrigation system. Damage is usually detected through plant behaviour.
- Problems with the wet bulb volume in land with a high level of infiltration.
- Risk of salinisation as a consequence of inadequate irrigation management.

Water saving improvements | PRECISION AGRICULTURE

Precision agriculture is a step forward in the efficient management of agriculture holdings through the use of available technology. The main aim is to streamline consumption, both of water and fertilisers, applying the products where they are needed and in appropriate amounts. It seeks to reduce costs, save water and/or improve product quality. It also reduces the negative impacts on the environment
This practice is highly recommended given the current framework for efficient water resource management, such as the Catalonian government's Plan for Efficiency in the Use of Farming Irrigation Water. However, it requires a high level of technical knowledge related to agricultural matters.

Regulated deficit irrigation (RDI)

This is based on reducing the water supply during the stages of crop growth in which a water restriction does not significantly affect the production and/or quality of the crop as all of the necessary evapotranspiration is covered during the rest of the cycle.
Woody species are the most suited to RDI. It is recommended to carry it out on adult trees so that the fruit yield is not affected. In Catalonia, the most common crops on which regulated deficit irrigation is carried out are citrus, olive and almond trees and grape vines. This technique can also be applied to extensive farming such as that of wheat or maize.
Originally, the aim of regulated deficit irrigation was to favour the growth of the fruit over the growth of the branches and thus regulate the growing period of the plant. Today, regulated deficit irrigation enables other benefits to be enhanced such as improvements in the appearance of the fruit and improved preservation post harvest.
The key factors when planning RDI are the crop and its production cycle. When the crop is in shallow soil with a very low water storage capacity, the effect of restricting the water is much more evident and effective as the water availability can be regulated more effectively.
This irrigation system entails significant savings in terms of irrigation water and pruning work, which translates into a reduction of direct crop production costs and water consumption.

Support irrigation

This is based on maximising efficiency in the plant's water use, providing water in the growing stages in which the crop is at its most sensitive, considering the critical periods in which restricted irrigation could considerably affect the production and/or quality of the crop.
This technique is used to maximise the efficiency of the available water resources when they are insufficient to cover all of the evapotranspiration requirements of the crop cycle. A very clear example is the olive tree. In this case of deficit irrigation, it is not a matter of maximising production (a situation which would require a volume of water that is not available) but simply to improve production in drought conditions by applying the volume of water available.
In the case of the olive tree, there are two critical periods leading to crop water requirements in drought conditions; the first corresponds to the stages of leaf growth, flowering, olive formation and shedding of flowers, and the second period starts when the fruit changes colour from green to yellowish shades, indicating that oil is beginning to accumulate in the pulp. This period is also important as it is when the tree builds up reserves for the winter.

Partial root drying

This system seeks to increase the efficiency of water use by reducing plant transpiration.
When the root system of a plant is dry and therefore detects a situation of drought, it naturally produces a substance (abscisic acid) which it sends to the leaves, causing the stomata to close and reducing transpiration and water loss.
This system is based on this mechanism, but if applied to just one part of the plant root system, the dry part generates the substance which enables the leaf stomata to close and the wet part supplies the plant with water without affecting the water potential of the leaves.
The system of partial root drying requires dry areas to be alternated to keep the formation of abscisic acid constant, as the plant stops producing this substance if the same dry area is maintained. The frequency of this alternation varies and depends on the type of crop and soil. To implement this system, each plant needs two rows of drippers, so that irrigation can be alternated, keeping one area wet and the other dry.

Crop monitoring

Crop monitoring is a technology that focuses on monitoring certain properties of the plants with the aim of detecting crop water stress in real time and reducing the time spent making decisions.
It is based on the placement of sensors in the field, which are connected to an interface with a data recorder and a transmitter that transmits the data to a computer using the telephone network (mobile or landline), all in real time.
This technology is currently used in both public and private research. However, elements such as soil moisture meters or stem diameter sensors are becoming increasingly common in commercial plantations.