A “silver bullet”?

The growth and doubts of drip irrigation

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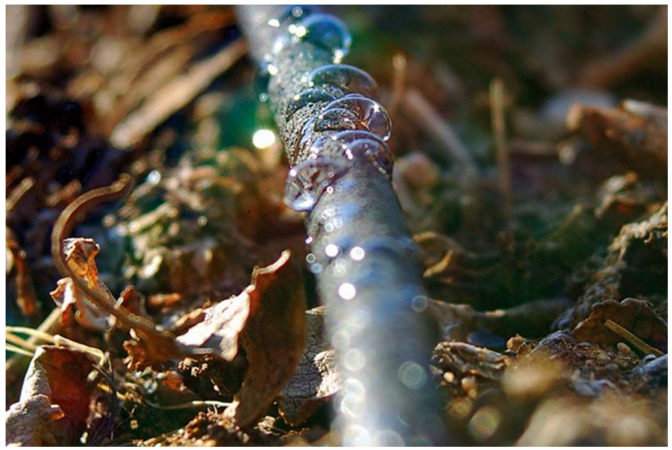

Photo: J. Elliot

“At the beginning of the twenty-first century, a powerful discourse had built up that made drip-irrigation synonymous with modernisation”

Ever since their conception, it is unlikely that the irrigation systems of the Mediterranean side of the Iberian Peninsula have experienced a technological change of as much scope and implication as that which has occurred in the last thirty years as a result of the introduction of drip irrigation. Hundreds of thousands of fields that have for centuries been managed through flood or furrow irrigation, now receive water from pressurised pipes. Irrigation channels, dykes, and sluice gates have given way to pipes, tubes and drippers, while irrigation ponds and control cabins have sprung up in droves across irrigated areas. Only in countries as vast as India and China is there a larger area of localised irrigation than that found in Spain today.

The process of technological change forms part of a series of measures that were introduced in many semi-arid regions of the world during the last quarter of the twentieth century. Following a prolonged period of implementing a water supply management model—where

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public administrations demonstrated an enormous commitment to the development and expansion of irrigated areas—in recent years, in view of the depletion of resources in numerous basins, we have witnessed a shift in hydraulic policies towards demand management, pursuing the reduction of water use through various mechanisms, with a particular emphasis on water-saving technologies. In this context, drip irrigation was likened to a “silver bullet” by some international publications, seen as having the ability to free up water resources and rebalance depleted basins through water savings.

Hundreds of thousands of fields that have for centuries been managed through flood or furrow irrigation, now receive water from pressurised pipes. The photograph above shows an orange grove with a drip irrigation system. / Mar Ortega

The growth of drip irrigation networks

This technology was developed by the engineer Simcha Blass at a kibbutz in the Negev Desert in the early 1960s. It was an idea that Blass had forged decades earlier, but it could only become a reality once the use of plastic became widespread. In the following years, his innovation was tested in laboratory conditions and in numerous experimental stations, where the capacity of localised irrigation systems to reduce water use, without impairing the water consumption of plants, was demonstrated. Stories from around the world of successful experiences with various crops and under different climatic conditions encouraged the spread of the new tool. Subsequently, many governments have incorporated these technologies into their hydraulic planning, such as Morocco’s Green Plan, Argentina’s PROSAP (Provincial Agricultural Services Programme), or Australia’s modernisation plans, not forgetting India’s National Micro-Irrigation Mission. In addition, the United Nations Food and Agriculture Organisation (FAO) and several NGOs have recommended the development of low-cost drip irrigation equipment as a key tool to break the water-food-poverty nexus in countries of the South.

Drip network in a field of Biar (Alicante). / Carles Sanchis

In Spain, the spread of localised irrigation began in the early 1980s. The irrigation technique first proliferated in large farms with an unreliable supply of water resources, or which were dependent on groundwater. The new irrigated areas of the region of the Vega Baja were the quickest to adopt drip irrigation, without support from the State. The Spanish Government's commitment to new water-saving technologies was set in motion during the 1994–1995 drought, just after the failure of the 1993 Hydrological Plan. It was aimed, as in other arid and semi-arid areas, towards the reduction of agricultural demand (representing about 80% of national demand at the time), but it also featured a clear political element. The efficiency and productivity of drip irrigation became the banner for arguments calling for the transfer of water resources, as happened in the cases of the Tajo-Segura, the Ebro-Sur and the Júcar-Vinalopó. There was a need to demonstrate that every last drop of water was being used in order to aspire to obtain new resources, or use the new improvements to survive without them.

An increase in the usage of drip irrigation was the only point of consensus between those who advocated a rapid transition towards more sustainable models of use and those in favour of increasing the provision of resources through transfers between basins. It was a conflict-free solution that benefited all the sectors involved and fulfilled all the policy messages; a winning option without a doubt.

"The spread of this technology, generously subsidised by the State, has been too rapid and undertaken without much consideration"

At the beginning of the twenty-first century, a powerful discourse had built up around the concept of the "modernisation" of irrigation, which led farmers, the government and also many experts to speak of drip-irrigation as being synonymous with modernisation. This discourse was based on the recommendations of international technical documents and on the estimated water-savings in scientific studies on irrigation efficiency. However, it was also strengthened by the enormous seductive capacity of the notion of modernity and by the need to clean up the image of irrigation, which was—often unjustly—branded as wasteful.

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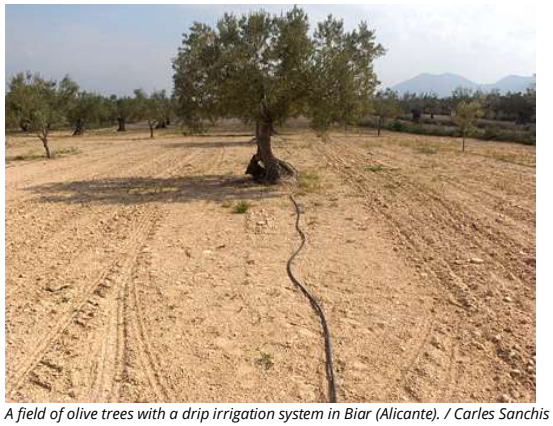
The majority of farmers valued—to the same extent or even so more than the saving of water resources—other advantages that could be produced by the incorporation of pressurised networks. If there is one aspect that farmers can generally agree on, it is the convenience and the improvement in their quality of life that the installation of pressurised irrigation provides. The possibility of implementing irrigation systems that allow them to water on demand—with the consequent eradication of watering at night—the introduction of centralised fertigation, and a reduction in the tasks of preparing the land for irrigation, generate a significant reduction in working hours, which has a positive effect on operating costs and gives them a better work-life balance, whilst also making time for other work activities. In addition, the improvement of the production obtained in most crops gives the farms that incorporate these technologies a considerable competitive advantage. The truth is that, although some do exist, it is difficult to find farmers who regret having changed the irrigation system.

"The adoption of localised irrigation was highly effective; it seemed to increase production while also decreasing the input of water to the plot"

This alliance of interests between the government and the agricultural water users was joined by the professionals and business groups who benefited from the installation and maintenance of the new infrastructures. In some cases, it was the marketing departments from pressurisation system companies who approached irrigation communities about initiating the modernisation project, even advising them on how to process their subsidy applications. However, there was no shortage of voices denouncing the fact that, in many places, drip-irrigation was being installed as a matter of course, without regard to the necessary technical requirements, as Teodoro Montalvo warned in the Autonomous Community of Valencia's White Paper on Water, in 1985.



A field of olive trees with a drip irrigation system in Biar (Alicante). / Carles Sanchis

A paradigm shift

Right at the time when most irrigation systems in the Mediterranean area were undergoing their transformation, in the years around the turn of the century, several scientific investigations began to question the efficiency of these irrigation technologies. These published works did not question the success of the technology at the plot scale, but they qualified their findings with reliable data on the water savings in some communities of irrigators and, more importantly, the effects at the basin scale. Until that time, the analysis of drip irrigation had not focused on investigating the repercussions that the new technology had beyond the plot, on the rest of the water system. In many cases, counterproductive effects were observed.

The adoption of localised irrigation was highly effective; it seemed to increase production while also decreasing the input of water to the plot. However, most of the savings were achieved because drip irrigation drastically reduces percolation to the aquifer and completely eliminates the surface runoff that used to occur in traditional irrigation, where the portion that did not evaporate frequently supplied adjacent fields and ecosystems. In short, the savings were largely made on resources that were not really lost, but were taken advantage of by other uses of the water system that, logically, would have to be replaced in order to not create any adverse affects. It could be the case that, at the basin scale, modernisation would eventually lead to the demand for more resources, instead of savings. This situation is known as the rebound effect and is a manifestation of the famous Jevons paradox, developed by the British economist in the nineteenth century when he discovered that the increased efficiency in the use of coal led to a rise in demand from industry.

Drip irrigation was likened to a "silver bullet" by some international publications, seen as having the ability to free up water resources and rebalance depleted basins through water savings. Above, a metering cabin in the Acequia Real del Júcar. / Mar Ortega

During the first years of the twenty-first century, this unexpected effect was detected in many parts of the world. In various places, using different methodologies, an increase in the

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use of water at the basin scale was observed in areas where pressurised irrigation had been introduced, not only for the aforementioned reason, but also for other practices that countered its potential to save water. One of the most common mistakes was to allocate the resources "freed up" by the new technique to expand existing irrigation or to create new irrigated areas, which resulted in an increase in the total demand of the system. In other cases, farmers took advantage of the resources made available from savings to adopt farming models that were more intensive, or with a higher demand for water, which reduced savings to zero, or even moderately increased demand. Occasionally, new environmental demands arose in order to repair the impact that the technological change had on the adjacent ecosystems—especially wetlands—which had been deprived of the water left over from irrigation that had traditionally nourished them, albeit partially. There was also no shortage of cases where, due to their lack of training, farmers applied the same volumes of water as they had used in flood irrigation, nor of facilities that, due to construction or design errors, did not properly serve the purpose for which they had been designed.

The observation of this rebound effect broke the consensus surrounding the new technology. Some researchers went so far as to assert that there was no conclusive scientific evidence to support the widespread belief that drip irrigation saves water (in net terms or at the basin scale). Thus, a new critical paradigm has arisen in response to the miraculous "silver bullet", and debates on the advisability of the State continuing to give financial support to this transformation have been frequent in professional and academic forums. In some of these forums, there is a disturbing tendency to polarise the debate into those who are supporters and those who are opponents of the tool.

"There was no shortage of voices denouncing the fact that, in many places, drip-irrigation was being installed as a matter of course, without regard to the necessary technical requirements"

What has happened to the irrigated land in Valencia, where more than 68% of the irrigated area has already been transformed? It would seem that the rebound effect is under control, mainly because there has been no change in crops or varieties towards more intensive models, nor has there been a significant expansion in irrigation (on the contrary, a decrease can be observed in most of the irrigable areas due to the aging of agricultural assets and the fall in the prices of production). According to studies carried out by the Valencian Centre for Irrigation Studies in 77 communities of modernised and non-modernised irrigators, the reduction in water demands that can be directly attributed to the adoption of drip irrigation is between 25% and 30%. The implementation of this technology has given these organisations an improved guarantee of supply and greater resilience in situations of drought. However, it should be noted that there are cases in which the economic viability of the organisations has been put at risk, due to them having made very demanding financial commitments.

The image shows a field of persimmons in which drip irrigation has been installed. / Mar Ortega

It remains to be seen, however, what part of this demand can be considered a net saving, that is, how much of the water that these communities have stopped using was being used to recharge aquifers, or to supply ecosystems and other adjacent irrigable areas. This figure is very difficult to ascertain. It requires setting up monitoring systems both before and after the transformation and there are hardly any references of real cases, although there are indirect models and calculations. In the case of Valencia, the Júcar Hydrographic Confederation estimates, with some degree of caution and according to its own data, that approximately a quarter of the gross savings could correspond to net savings. These are general values, which surely conceal deficiencies and shortcomings on a local scale that should be corrected in order to maximise the potential of this tool.

Further questions

Water saving is not the only uncertainty raised by the adoption of localised irrigation. The consumption of energy (necessary to pressurise the irrigation networks) has also been the subject of study, featuring investigations with substantiated findings. In general, what the analysis of the Valencian case shows, coinciding with studies made in Australia and in other regions of the Spanish peninsular, is that in irrigation systems supplied with groundwater, the use of energy decreases, because pumping of the aquifer also decreases. However, in the majority of areas with surface water irrigation, energy consumption increases significantly and this contributes to raising the costs borne by users, in a context of high electricity prices. Amongst these studies, however, there is a clear consensus among researchers on the necessity of establishing energy audits, given that there is a firm belief that the design and management of many facilities can be significantly improved.

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Detail of a valve in the pressurised irrigation system in the Acequia Real del Júcar. / Mar Ortega

Water and energy are two of the most evident and disturbing aspects, but there are other unanswered questions and debates concerning this technological leap that are prompting agro-environmental research, which should determine the future actions of the government. The loss of resources suffered by ravines, rivers and wetlands adjacent to the transformed systems must be analysed, and corrected if necessary. The means of integrating organic farming into networks that generally have centralised fertigation systems must be resolved. It is necessary to analyse, in certain areas, the impact on soil salinity. More specifically, we must think about how to solve the effect this condition has on the historical irrigation heritage, at a time when it is being highlighted as a cultural and touristic resource in the rural environment (there are new technological and management alternatives for historical irrigation networks that enable a notable increase in the efficiency, productivity and convenience of maintaining irrigation by gravity).

In short, recent research shows that, if the scale of analysis and the variables under consideration is increased, the utility of the tool depends on numerous contextual factors, not just hydraulic or agronomic factors, but also territorial and socioeconomic ones. The expansion of this technology, generously subsidised by the State, has been too rapid and undertaken without much consideration. It is necessary to design a second-generation modernisation strategy, dedicated to correcting the defects and negative impacts of this first wave of transformation and maximising the potential of this technology, in line with mitigation strategies and adaptations to climate change scenarios.

Recent research reminds us, therefore, that no matter how often they are mentioned in scientific literature, silver bullets are a product of fiction.

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