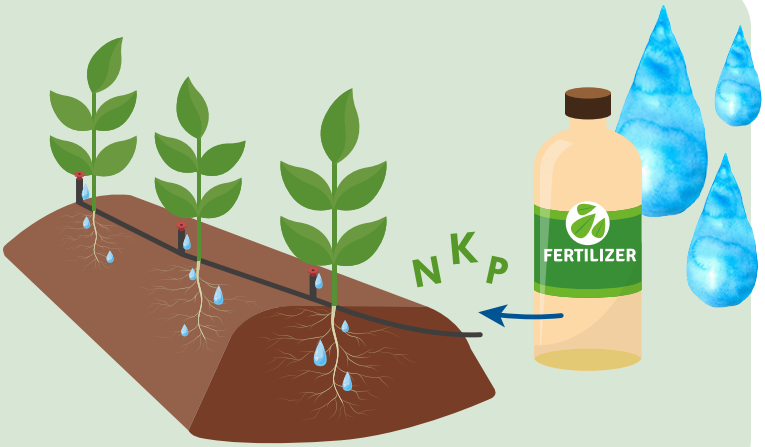
INTERNATIONAL FERTILIZER ASSOCIATION

Submission of the International Fertilizer Association to the UNFCCC
Koronivia Joint Work on Agriculture
**Topic:** Sustainable land and water management, including integrated watershed management strategies, to ensure food security

# FERTIGATION
## A Nutrient- and Water-Efficient Precision Agriculture Tool

Much of the extraordinary growth in agricultural productivity achieved during the past 50 years has been powered by applying plant nutrients and increasing irrigation from surface water and groundwater sources. Currently, agriculture accounts for about 70 percent of all water withdrawals from aquifers, streams and lakes[1]. Due to converging uses, impacts to water quality and climate change, water scarcity is becoming an increasing concern for agriculture and food security.

**Fertigation is the process of applying water-soluble fertilizers through irrigation systems to supply plants with their daily water and nutrient needs for their specific growth stage, following the principles of 4R Nutrient Stewardship (using the right source at the right rate, time and place).**




## KEY MESSAGES

- **Fertigation can help sustainably grow more food in a changing climate** while radically reducing the use of precious resources such as water and minimizing nutrient losses to the environment.

- By allowing fertilizer applications rates to be dosed according to plant uptake rates, distributing nutrients directly to the root zone, and maintaining a constant level of low but accessible nutrients in the soil solution, **fertigation can result in high crop yields and up to 90 percent nutrient use efficiency[2].**

- By delivering relatively small amounts of water to where plants need it, **microirrigation-based fertigation offers up to 90 percent water use efficiency[3].**

- Using fertigation in microirrigation systems, **vast areas of arid and semi-arid land and other marginal soils can be used to grow produce** which could help feed the 25 percent of the world's population currently living in regions of extremely high water-stress[4].

- With 14.4 million hectares of the world's soil estimated to be using microirrigation systems in 2018[5], **there is considerable potential for the wider adoption of fertigation.**


1 https://www.worldbank.org/en/topic/water-in-agriculture
2 Solaimalai A, Baskar M, Sadasakthf A and Subburamu K (2005) Fertigation in high value crops - A review. Agriculture Review 13-: 126
3 http://www.fao.org/fileadmin/user_upload/agwa/docs/Efficiency_Thematic%20Brief_En.pdf
4 https://www.wri.org/blog/2019/08/17-countries-home-one-quarter-world-population-face-extremely-high-water-stress
5 https://www.icid.org/9imic2019_papers/9th_imic_st1_paper%20(2).pdf

## IMPROVED WATER MANAGEMENT

A quarter of the world's population across 17 countries, including in India, the Middle East and North Africa are already living in regions of extremely high water-stress.[6] By 2050 that number is predicted to rise to 52 percent of the world's projected 9.7 billion population.[7]

Microirrigation and hydroponic-based fertigation have extremely high water use efficiency.

In microirrigation (drip, sub-surface, spray, micro-jet and micro-sprinkler), water is applied in short intervals that deliver relatively small amounts of water per unit of time from each sprinkler, jet or emitter. In hydroponics, nutrient-enriched water is supplied directly to crops in soilless growing conditions.

**Using fertigation to efficiently deliver water and nutrients at the same time to exactly where they are needed can reduce the volume of water used compared to conventional agricultural systems and can achieve up to 90 percent water use efficiency.** Improvements to root health and mass produced by fertigation also results in plants that can trap and hold water far more efficiently.

By using partially treated wastewater, potentially containing additional nutrients, **fertigation can also help turn waste into a resource, which is particularly important in areas with high water stress, such as heavily urbanized regions.** Moreover, fertigation with treated wastewater is considered the most economically feasible and environmentally friendly method of wastewater disposal.

With food insecurity a growing global challenge, fertigation is a sustainable solution that can help grow enough food, especially in the many parts of the world facing increasing droughts and water shortages and when non-traditional water resources are used for irrigation.

## OPTIMIZED NUTRIENT UPTAKE FOR PLANTS

Fertigation provides an excellent opportunity to maximize yield and minimize environmental losses8 by increasing fertilizer use efficiency, minimizing fertilizer application and increasing return on the fertilizer invested. **In fertigation, the timing, amounts and concentration of fertilizers applied are easily controlled.**

By allowing water-soluble fertilizer to be dosed according to plant uptake rates, distributing nutrients directly to the root zone, and maintaining a constant level of low but accessible nutrients in the soil solution, nutrient and water use efficiency, as well as crop yield and quality, can be maximized. At the same time over-fertilization and potential nutrient losses to water and the atmosphere can be minimized.

Due to the combination of precise amounts of nutrients with small amounts of water, **fertigation can produce up to 90 percent nutrient use efficiency.** It can also reduce nitrogen run-off compared to other fertilizer application methods, while also needing less fertilizer to produce the same crop yields which can reduce the cost of inputs for farmers.

## AN ADAPTABLE, SCALABLE AND SUSTAINABLE SOLUTION TO GROW CROPS ALMOST ANYWHERE

Microirrigation and hydroponic-based fertigation bring numerous benefits to farmers and can be used in a wide variety of soils, climates and locations. It can produce high, stable crop yields and improve crop quality while using water and nutrients very efficiently. By automating water and fertilizer applications it also reduces the amount of labour required, which combined with less fertilizer needed can reduce overall operating costs.

Fertigation is already widely employed in commercial horticulture globally to grow high value flowers, fruits and vegetables in greenhouses and orchards such as almonds in California and olives in Europe and the Mediterranean. It has also been used in areas with drier climates such as maize production in some parts of the U.S. Midwest and wheat production in Canada.

Deserts are traditionally hardly used for farming under regular sprinkler irrigation, or by flood irrigation, as they are usually located far away from water sources and have very low water holding capacity. **Microirrigation-based fertigation has allowed deserts to be turned into productive agricultural soils for high cash crops** such as dates[9]. In the extremely arid Negev desert in Israel, for example, fertigation is used to grow tropical crops such as mangoes using very little water.

Fertigation can also be used to successfully cultivate crops in other marginal soils not usually deemed appropriate for productive agriculture, helping to avoid the potential biodiversity and carbon losses that arise when natural ecosystems are converted to farming.

6 https://www.wri.org/blog/2019/08/17-countries-home-one-quarter-world-population-face-extremely-high-water-stress
7 https://news.mit.edu/2014/predicting-the-future-of-global-water-stress
8 Hagin, J., M. Sneh, and A. Lowengart-Aycicegi (2002) Fertigation – Fertilization through irrigation. IPI Research Topics No. 23. Ed. by A.E. Johnston. International Potash Institute, Basel, Switzerland Institute, Basel, Switzerland.
9 Kafkafi, U. and B. Bar-Yosef. 1980. Trickle irrigation and fertilization of tomatoes in highly calcareous soils. Agron. J. 72:893–897

Despite its numerous benefits, managing the complex combination of nutrient and water supply can make fertigation a challenging technique. To meet crops' nutrient needs while minimizing losses, growers must accurately estimate crop nutrient requirements, soil nutrient availability and ensure the delivery of nutrients as well as water at the right times.

A growing range of optical, multispectral and soil-based sensors can measure plant stress as well as nutrient content both in the canopy and at the root zone. This data can then be fed to smartphone-based decision support systems apps, which also use algorithm-based modeling to give advice on crops' water and fertilizer requirements tailored to specific areas in a field, with intelligent automated delivery systems precisely administering the results. In addition, simple but effective low-tech fertigation options, for example using tape-based drip irrigation systems and hand pumps, are being used.

## TOWARDS A WIDER ADOPTION OF FERTIGATION

While microirrigation-based fertigation is already used extensively in some regions, such as in 80 percent of Israel's 200,000 ha of irrigated land[10], **there are significant opportunities for wider scale adoption.**

The last three decade have seen a rapid increase in the use of microirrigation systems globally, helped by decreasing costs. In 2018, the total worldwide area cultivated by microirrigation was estimated to be 14.4 million hectares, representing 6.2 percent of the total irrigated area (231.9 million hectares) and a 25-times increase over thirty years.[11]

Much of the world's irrigated land still uses practices that are not optimal for efficient fertigation, however, such as flood irrigation, including in China and India, which irrigate around 52 percent and 30 percent of their cropland respectively[12]. In other regions, meanwhile, there is very little irrigation at all, such as only 4 percent of the total area cropped in Africa[13].

Subsidies for drip irrigation hardware in countries including India, China and Morocco, as well as cheaper low-pressure drip systems and solar powered pumps, are helping to make microirrigation more affordable, but microirrigation remains inaccessible to many farmers, particularly smallholders in off-grid environments. Introducing advanced fertigation into microirrigation systems can also be a challenge, with barriers to wider adoption including access to regular soil testing, investment in an appropriate delivery system and the higher cost of some water-soluble fertilizers, though many mainstream water-soluble fertilizers can be used.

**In water-stressed regions, farmers cannot cultivate all of their land due to the limited amount of water available. With fertigation, these farmers can cultivate a larger portion of their land and produce more food with the same amount of water while using the same or less fertilizer, thus enhancing water productivity, nutrient use efficiency and their incomes.**

As climate changes and water stress increases, there is a great opportunity for governments, non-governmental organizations (NGOs) and the private sector to partner to encourage the wider adoption of microirrigation and fertigation. To help sustainably feed the world while protecting the planet, the future of agriculture should be increasingly fertigated.

10 https://www.fertilizer.org/images/Library_Downloads/2015_ifa_fai_newdelhi_kalyan.pdf
11 https://www.icid.org/9imic2019_papers/9th_imic_st1_paper%20(2).pdf
12 https://www.indexmundi.com/facts/indicators/AG.LND.IRIG.AG.ZS
13 https://www.indexmundi.com/facts/indicators/AG.LND.IRIG.AG.ZS