McDonald's Europe Flagship Farms

Lettuce – Primaflor Farm, Spain

Introduction

This case study shows how lettuce production in an area of low rainfall can be undertaken by using water in an efficient and precise manner, combined with targeting application of fertilisers and plant protection products (PPP) to improve their effectiveness and protect the natural environment. This case study highlights good practice in water use, agrochemical and fertiliser use and food safety.

The key initiatives undertaken by Primaflor can be summarised as follows:

- The farm produces the lettuce under the requirements of the GlobalGAP Assurance Scheme. This ensures that practices such as food safety/quality, good environmental management, record keeping and worker welfare are all independently audited and verified.
- The farm uses fertigation (the application of fertilisers or other water soluble products through an irrigation system), which provides precise application and reduces the overall amount of products applied compared to granular application. All planting areas are soil tested annually for key nutrients to ensure levels are appropriate to crop demand.
- Primaflor uses GPS satellite guidance systems to allow field shape and slope to be factored into field preparation. The main objective is to optimise the usable field area and improve the efficiency of cultivation, planting, irrigation and harvesting.
- The farm now uses mechanised planting, weeding and harvesting, this has helped the business reduce staff numbers by 32%.
- Pheromone and sticky traps are used to capture pest species and if threshold levels are exceeded then the farm's technician can approve the use of specific plant protection products.
- Biological repellents (garlic extract and neem oil) are used to control certain target pest species.
- Sub–surface drip irrigation is used, which minimizes the use of water by allowing it to drip slowly to the root zone of plants. It is estimated to be 25% more efficient than other methods of irrigation. Irrigation levels are monitored by soil moisture meters.
- The weather station on farm predicts likely rainfall events and calculates soil evaporation rates, this helps improve irrigation efficiency. It also predicts weather conditions which are likely to increase the risk of disease or pest outbreaks. This data feeds into desicion support software, allowing accurate and targeted use of PPP's.
- To improve the natural environment around 500 native trees have been planted around the farm, these include Olive, Palm, Carob and Oleander (Nerium Oleander L.).

> "The amazing array of technology and good practices at play here show what is truly possible in the production of agricultural products. There are practices that have been put in place because they have an economic benefit, but what has also been considered is the beneficial impact that they have on the environment. Reducing the requirements of fertilisers, pesticides and water is one of the most important and pressing sustainability aspects of modern agriculture and Primaflor have taken up this challenge."
>
> Karl Williams, Flagship Farms Programme Manager, FAI

“We are very proud for being invited to participate in the McDonald’s Flagship Farm programme, because we think it is a result of hard work throughout the years in the areas of quality, food safety and environmental issues. For us, it represents a challenge to improve the confidence of the consumers, producing safe and quality products in a sustainable way:

- Optimising water and fertiliser use, sub–surface drip irrigation, soil moisture probes, and advanced fertigation technology.
- Introduction of new varieties, resistant to pest and diseases, and adapted to our conditions to obtain the highest quality all year round.
- Implementation of pest and disease control strategies developed in collaboration with the main chemical companies, optimising the efficiency and minimising residues.
- Producing safe products, very rigorously controlled by our quality control department, through a huge quantity of micro and residues analysis.
- Introducing environment integration programs in order to minimise the impact of growing.

We have achieved several different quality certifications, based on good agricultural practices, quality, food safety, environmental respect and ethical trading. The final customers of our products would possibly be unaware of the effort and practices made to obtain these certifications and by taking part in the Flagship Farm project we can show a wider audience what we have achieved.”

Antonio Marhuenda, Production Director at Primaflor

Summary of actions

The table below summarises the key areas of good practice displayed by Primaflor Farm, and the benefits (EN **environmental** / EC **economic** / ET **ethical**) that arise from taking these actions.

	Action	Benefits
Certification/ Assurance	**GlobalGAP approved**	EN GlobalGAP audits environmental criteria within its standards, which ensures the farming practices are not harmful to the environment ET GlobalGAP standards are designed to ensure that food quality, food safety and worker welfare is well managed
	SA8000 implemented	ET Guarantees good working conditions for all employees
Agrotechno–logy	**Fertigation system**	EN The majority of nutrients are applied via the irrigation system which reduces losses and decreases the risk of pollution EC Nutrient application rates are matched precisely to plant requirements, leading to lower fertiliser costs and optimal plant growth
	GPS satellite guidance systems	EC Improves the efficiency of cultivation, planting, irrigation, harvesting and ensures accurate application of PPP's via the crop sprayer
	Mechanised planting, weeding and harvesting	EC Reduced costs associated with manual labour, this has helped reduce staff numbers by 32% EC Improved plant establishment and more uniform crop growth, as a result lettuce can be harvested five days earlier
Crop initiatives	**Pheromone and sticky traps**	EN Allows monitoring of crop pests, ensuring PPP's are only applied when pest threshold levels are exceeded EC Allows for targeted and necessary use of PPP's
	The use of biological repellents	EN The repellent causes no harm to beneficial insect species EN Reduces the requirement of plant protection products (PPP)
	Working with plant protection product companies	EC Optimum pest control strategies being developed with PPP companies
Product Quality	**Selective breeding to develop resistant varieties**	EN Improved plant resistant to crop disease and pests reduces the requirements for EC PPP's and lowers cost of production
	Veg–i–trade and food security	ET Research on irrigation levels to evaluate their influence on product shelf life and quality for iceberg lettuce and romaine
Water	**Soil moisture meters connected to computer software**	EN Soil moisture levels can be accurately monitored to meet the plants requirements whilst ensuring water does not move beyond the plants' root zone EC This optimises water use to plant growth
	Sub–surface, pressure compensated drip irrigation system	EC Reduces water consumption via accurate placement of irrigation into plants root zone with minimal losses due to evaporation
	Weather station	EN Monitors weather conditions which provides data for irrigation planning EC Identifies weather conditions which may increase disease and pest outbreaks which provides data for the desicion support software
	Microbial testing of water	EN All irrigation water is tested for purity
Biodiversity	**Environmental Integration Plan**	EN A regime of tree planting with natural species is being carried out EN A protected area of 30 hectares has been established for a rare species of plant (Testuda Graeca)

See Appendix 3 for Primaflor's Good Practice Matrix

Background

Primaflor was originally founded in the 1970s and grew flowers and vegetables for the domestic and export markets. In the 1980s the business expanded and consolidated its interests, and the focus changed to producing leaf vegetables.

Facts: Lettuce
Lettuce (Lactuca sativa L.) is an annual plant species of Asteraceae (daisy family) and is native to the Mediterranean region. It has been cultivated for over 2,000 years and is thought to have originated in Europe and Asia. The annual European production of lettuce is estimated at around 2.4 million tonnes.

The business is currently farming some 4,300 hectares of land in Almeria, Spain, growing around 55 different vegetable varieties. Iceberg lettuce comprises around 70% of the production, equating to around 60,000 tonnes of Iceberg (each head weighs around 500 grams) produced annually, in current terms, 10% of Spain's total production.

The farm "Fatima" has been selected by the company as their representative for the Flagship Farms project and covers an area of 212 hectares, with 135 hectares planted with Iceberg lettuce.

Facts: Lettuce types
There are four commonly recognised groups of lettuce:

1. The Butterhead, which forms loose heads and has a buttery texture.
2. Crisphead, also called Iceberg, which forms tight, dense heads that resemble cabbage. They are generally the mildest flavoured of the lettuces, valued more for their crunchy texture.
3. Looseleaf, which has tender, delicate, and mildly flavoured leaves. This group comprises oak leaf and lollo rosso.
4. Romaine, also called Cos, grows in a long head of sturdy leaves with a firm rib down the centre.

Certification / assurance

GlobalGAP approved

The farm is GlobalGAP approved. This means that an independent certifying organisation audits the farm to the requirements of the scheme, which is primarily designed to maintain consumer confidence in food quality and food safety. Other important goals of the scheme are to minimise any detrimental environmental impacts of farming operations, optimise the use of inputs and ensure a responsible approach to worker health and safety.

ET

EN

By complying with the GlobalGAP standard the farm demonstrates its good practice in terms of food quality, safety and environmental practices.

SA8000 accredited

The SA8000 is fully implemented within the business, which is an international standard for improving working conditions. Based on the principles of thirteen international human rights conventions, it is a tool to help apply these into practical work–life situations. SA8000 was the first auditable social standard and creates a process that is independent (it is neither a government project, nor dominated by any single interest group).

Agrotechnology

Fertigation

The farm uses a fertigation system, which is the application of soluble fertilisers through an irrigation system. This provides precise nutrient applications to the plant, and the system in use also controls the pH levels of the irrigation solution. The business has a defined plan for nutrient application which is implemented on the basis of planting dates, soil type and crop type. All planting areas are tested annually for nutrients to ensure accurate application. This method of scheduling reduces the effects on the plants of over– or under–fertilising and results in optimum plant growth.

> "...Of equal importance is a correct control of the pH. The pH control of the irrigation solution is an important part of the nutrient uptake of the plants. It has been clearly demonstrated that a pH around 6 optimises the application and absorption of fertilisers."
>
> Abstract from Innovaciones Techicas Agricolas website

ET

EN

Use of fertigation ensures accurate and precise nutrient application, ensuring minimal waste and maximising plant growth.

Fertigation allows the plant to absorb up to 90% of the applied nutrients, whereas granular fertiliser applications typically result in absorption rates of 10–40%. Another drawback of granular fertiliser applications is that they rely on rain or topical applications of irrigation (which is wasteful due to high evaporation losses) to dissolve the fertiliser granules.

As the fertigation system is targeted at the plants' root zone the risk of runoff or leaching is greatly reduced, which is also aided by the small amounts of fertiliser required for each drip cycle. With this precise application method and defined planning system, the overall amount of fertilisers applied is reduced.

See Appendix 1 for a list of prerequisites for successful fertigation.

GPS satellite guidance systems

GPS systems are being used in agriculture for field mapping, tractor guidance, variable rate applications of fertiliser and pesticides, and yield mapping. GPS technology allows site–specific management for the soil or crop to increase production or reduce the environmental impact.

Primaflor uses GPS technology to allow field shape, and slope, to be factored into field preparation. The objective is to optimise the usable field area and improve the efficiency of cultivation, planting, irrigation and harvesting. The technology is also used on the farm's crop sprayer to automatically switch off boom sections which avoids off target applications.

Mechanised planting

The mechanisation of the planting process has allowed an increase in planting speed and efficiency, with the benefit of improving worker comfort for those working on the planting machine.

EC Mechanisation has reduced staffing requirements by 32%

The mechanised planting has improved plant establishment and uniformity in the field, and this has allowed the crop to establish and grow faster. The outcome is that the crop can be harvested up to 5 days earlier than crops planted manually. The other benefit is that the crop is far more uniform which has helped with the introduction of mechanical harvesting (see mechanised harvesting).

This reduction in the growing period reduces inputs (water/fertiliser/PPP) along with their associated application costs.

Mechanised weeding

The development of guidance systems based on computer vision has meant that the required accuracy for weeding between row crops is easily achieved, and can be maintained for long periods, and at higher speeds than was previously possible with manually guided systems.

Primaflor recognised that these systems have a huge benefit over manual crop weeding (which is how it used to be undertaken on the farm), which is a tedious and costly task. By introducing the system high daily work rates have been achieved with only one staff member required to operate the tractor and weeder.

Facts: how mechanised weeding works
Images are analysed at a rate of 30 frames per second and the direction of the hoe adjusted via a hydraulic side shift with anti–backlash action. Accuracy is generally 15mm at the camera or with the addition of soil engaging discs better than 10mm accuracy is possible. Forward speeds of up to 12kph are common and higher speeds have been successfully employed.

Mechanised harvesting

Because of the extensive labour involved in manually harvesting lettuce, it is a significant cost to the grower.

Primaflor have introduced mechanical harvesting to help reduce the number of workers required to harvest the lettuce, and improve the working conditions of the remainder. Although these systems require a very uniformed crop (see Mechanical Planting), they provide the benefit of increasing harvesting productivity.

The mechanisation of field operations such as planting, weed control and harvesting, along with restructuring the workforce has enabled a reduction in the number of employees required by the business by 32%.

Crop initiatives

Pheromone traps

The use of pheromone and sticky traps capture pest species in field. When threshold levels are exceeded the farm's technician can approve the use of specific PPP's to deal with this in a timely manner, before excessive levels are reached which can cause crop damage and losses.

EN

Biological repellents and sticky traps are used on the farm, avoiding the negative environmental impacts associated with manmade chemicals.

Facts: benefits of using pheromone traps

- Monitors relative levels of pest activity during the season.
- Allows for decisions to be made on the basis of reliable estimates of pest numbers.
- Traps are species–specific.
- Used to determine spray requirements.

Working with plant protection product companies

Pest and disease strategies are planned out in conjunction with three specialist companies. DuPont develops caterpillar control, Sygenta works on fungus control and Bayer on botrytis control strategies. It is hoped that by working directly with these companies the farm is able to better control these conditions in the most economic and environmentally friendly manner.

Biological repellents

Biological control of insect pests is the only major alternative to the use of pesticides in agriculture. Biological repellents (garlic extract and neem oil) are used to control certain target pest species. Formulations made of Neem oil have a use as a bio–pesticide, as it repels a wide variety of pests including the mealy bug, beet armyworm, aphids, the cabbage worm, nematodes and the Japanese beetle (not all of these are pests to lettuce). Neem Oil is not known to be harmful to mammals and birds or to beneficial insects such as honeybees and ladybirds. Garlic extract has a reputation as both a prevention and cure and there seem to be few pest species immune to their characteristically strong smells. By using these two natural products they have the potential to reduce the impact on the environment.

Sufficient High Quality Production

Veg–i–Trade and food security

Primaflor participates in a European Project called Veg–i–Trade. This programme is funded by the Seventh Framework for Research of the European Commission. The project seeks to assess the impact of anticipated climate change and globalisation on the safety issues concerning fresh produce and derived food products. Research will be performed concerning the economic structure of the fresh produce chain, and control measures to minimise microbiological and chemical risks will be developed. (http://www.veg–i–trade.org/). Primaflor has participated in research on irrigation doses to evaluate its influence on product shelf life and quality for iceberg lettuce and romaine.

Planting for improved lettuce characteristics

A programme of plant breeding in conjunction with seed suppliers sees over 300 different varieties planted every week during the growing season, with the objectives of improving pest/ disease resistant and growth characteristics for future generations. Only 1% of the trialled varieties make it to commercial production, and it then takes a further three years until full–scale field production. It is hoped that these new varieties will reduce the requirements for plant protection products and fertilisers required to produce a marketable lettuce.

EC

EN

The farm plant breeding programme will decrease the need for intensive inputs in future species.

Soil Health

Annual soil testing and nutrient plans

All planting areas are tested annually for nutrients which prevents over application. Targeted fertiliser applications plans are implemented which maximises yields whilst optimising nutrient use.

Water

Soil moisture meters

Water is a precious resource in this growing region and also contributes around 20% to the cost of production. To ensure that irrigation is undertaken in the most efficient way the farm has integral soil moisture meters within the growing crop to monitor soil moisture levels. These have sensors set at four zones within the soil structure at depths of 10, 20, 30 and 50cm. These monitor moisture levels every five minutes and the data is sent via Wi–Fi to a nearby computer system.

EN

The farm's efficient irrigation systems maximise water for the crops while minimising waste.

The computer software charts the moisture levels. It also records the amount of water applied via the irrigation system and gathers data from the weather station. All these figures are then assessed by the farm's technician who can adjust irrigation amounts from the pre–determined target levels. Any rise in moisture levels recorded at the 50cm sensor shows that the crop has been over–irrigated and the technician will reduce the subsequent applications of water to address this. At 50cm the water has moved out of the plant's root zone and is therefore unavailable for its use.

Sub–surface drip irrigation

The farm's subsurface drip irrigation (SDI) uses a temporarily buried dripper line located at the plant roots. These are placed at 15cm intervals and have a flow rate of 0.6 litres/hour. These lines are typically removed and reinstalled up to four times before new dripper line is required, and at the end of its life it is recycled. This system has become popular for row crop irrigation, especially in areas where water supplies are limited as it is the most efficient irrigation system. This type of irrigation method minimizes losses by allowing water to drip slowly to the root zone of plants. It can be 25% more efficient than other methods of irrigation as it does not incur the losses through evaporation that topical applications of water are subject to.

EN Surface drip irrigation is up to 25% more efficient than other methods

Pressure–compensated drip irrigation system

The farm has gone one step further with the introduction of a pressure compensated drip irrigation system, which is more expensive to purchase than the conventional drippers but provides a higher degree of accuracy over the conventional system (see box, right).

Water testing

The farm is supplied with water from two sources and microbial testing is undertaken to ensure purity levels are consistently met. The main water source comes from the Guadiana Menor which flows into the huge Negratin Lake, the third largest of its kind in Andalusia, with a capacity of 5567Hm^3. A large underground pipeline conveys water from the Negratin Lake to two large reservoirs in the local area and this provides water for both regional agricultural production and domestic use.

Weather station

The on–farm weather station is a monitoring device that takes accurate, real–time weather measurements and transmits them to the farm's computer. It measures wind speed and direction, humidity, precipitation, temperature, barometric pressure, dew point and provides data to calculate soil evaporation rates, which is used within the irrigation models.

The farm is also able to use disease/pest prediction models which can direct the use of plant protection products in a timely and cost–effective manner.

EC EN The use of ongoing weather monitoring helps predict weather events and disease incidence, enabling approprate, low impact, preventative actions to be taken.

Biodiversity

Native tree planting

To date, the company has planted around 500 native trees around the farm, including Olive, Palm, Carob tree and Oleander (Nerium Oleander L.). When the weather improves after winter more planting will be carried out across the rest of the farms.

The business has established an area of 30 hectares to protect a rare species of plant (Testuda Graeca), the area is being monitored by the official agency for environmental management.

Appendix 1 – Prerequisites for Successful Fertigation

In fertigation, small doses of frequently added nitrogen prevent leaching. Fertigation is more advantageous in drip irrigation systems and better fertiliser distribution is achieved compared to furrow and surface irrigation. Drip irrigation also has higher water use efficiency and higher fertiliser use efficiency. Fertigation is also an efficient method for providing and supplying available forms of immobile elements such as phosphorus (P) at a desirable level in the root zone. This is especially important during the very first stages where P is badly needed for developing a good root system.

1. Since with fertigation, fertiliser application can be controlled better, over– fertilisation and over– irrigation at any growth period can be avoided. Thus, by synchronisation of water and nutrient supply with the crop demands, both water and fertiliser use efficiencies are improved and the adverse impact of over fertilisation on the environment is minimised. The nearer the time of fertiliser application to peak nutrient demand, the higher the utilisation efficiency of fertilisers.
2. Drip irrigation has proved to be the most efficient method of irrigation in terms of water saving and yield increase. Conventional fertilisation techniques are not suitable under drip irrigation farming system while fertigation is considered the only appropriate technique for fertiliser application. In fact, fertigation in many countries has gained momentum since adoption of drip irrigation systems. This is also of extreme important in countries where water resources quantitatively and qualitatively are limited.
3. By fertigation, one can avoid application of large amounts of solid fertilisers by conventional methods thus avoiding salt damages of plant roots.
4. By fertigation, one can minimise the losses by leaching and/or volatilisation because the nutrients are directly supplied into the root zone in small amounts and frequently according to the needs of each growth period.
5. Compared to soil application, fertigation can save time, energy, labour and overall application cost.
6. Frequent application of small doses of fertilisers with fertigation keeps the amount of fertilisers in the soil at any time low enough to minimise losses by leaching and runoff during heavy rainfall or excessive irrigation. This regulates nutrient uptake, minimises losses and increases fertiliser use efficiency.
7. With surface irrigation, soil varies from saturation to wilting point between irrigation.
8. Benefits of fertigation include reduction in soil compaction and mechanical damages to the crops due to reduced use of tractors and other heavy machines in the fields.
9. Fertilisers can be applied to the soil when conditions are inconvenient (wet soil surface, crops are growing, etc) for labour or equipment to enter the field to apply fertilisers by conventional methods.
10. By fertigation, immobile nutrients such as phosphorus and micronutrients will be supplied right into the root zone and the nutrients therefore are not widely mixed with the soil. Thus less soil volume is fertilised and less fixation, sorption or precipitation is taking place and fertiliser use efficiency is improved.

(Abstract from: Prerequisites for Successful Fertigation by M. J. RUSAN (Jordan University of Science and Technology))

Appendix 2 – Benefits of pressure–compensated irrigation systems

Non pressure–compensated drippers and drip–lines, regardless of manufacturer, will have a degree of output flow variation along a length of drippers. This is caused as the drippers' output flow is directly related to the water pressure acting on it. On any drip–line there will be pressure loss caused by friction in the pipe so as you move down the line each dripper has slightly lower pressure acting on it, so the dripper at this point gives a slightly lower flow.

The relationship between pressure and flow is called the exponent and is a factor that manufacturers measure. Netafim have an exponent of 0.4 to 0.46 dependant on dripper type, thus meaning if the pressure is increased by 100% on the dripper the flow will be increased by 40–46%. Lower quality drippers may have an exponent as high as 0.7. In practice on short row lengths the exponent can be overcome by good hydraulic design but on slopes greater than 1% or on longer row lengths (20m+) the exponent does have significant bearing. A well designed system can easily have 20–30% difference in dripper output between one end of a drip line and the other. This means either part of the crop is over– irrigated by 20–30% or part is under irrigated by 20–30% and with a corresponding situation where fertilisers are under or over–fed through the drip–lines.

(Source: Technical explanation of the benefits of the pressure compensated irrigation system by Julian Gruzelier from Eden Irrigation)

Appendix 3 – Primaflor Farm's Good Practice Matrix

The following matrix has been developed by McDonald's to help assess the sustainability of the agricultural production within the supply chain. Flagship farms have been identified that demonstrate best practice in one or more of the 17 key areas in the matrix, whilst also operating to general high agricultural standards in all other areas.

A ✓ in the matrix below indicates good practices demonstrated in this case study.

Ethical (Acceptable Practices) ET

Human health & welfare ✓
i Employee health & welfare ✓
ii Food safety ✓

Animal health & welfare
i Nutrition
ii Medication & growth promoters
iii Genetic selection
iv Animal cloning
v Husbandry
vi Transport
vii Slaughter

Business ethics & supplier relationships

Rural landscape preservation

Environment (protecting the planet) EN

Climate change
i Greenhouse gas emissions
ii Energy efficiency & renewables

Natural resources – soil ✓
i Soil fertility & health ✓
ii Soil erosion, desertification & salinisation
iii Soil contamination

Natural resources – water ✓
i Water pollution
ii Water usage efficiency ✓

Natural resources – air
i Air emissions

Agrotechnology ✓
i Agrochemical usage ✓
ii Bioconcentration & persistent organic pollutants
iii Genetically modified organisms

Ecosystem protection ✓
i High Conservation Value Land (HCVL)
ii Habitat & species preservation ✓

Waste
i Production waste
ii Hazardous waste
iii Waste to landfill

Economics (long–term economic viability) EC

Sufficient high quality production ✓
i Producer income security & access to market
ii Agricultural input costs ✓
iii Crop & livestock disease ✓

Community investment
i Local employment & sourcing
ii Support for community programmes