

Practice PF n° 19

INTEGRATING MULTISPECTRAL DRONE IMAGING, IOT SENSORS, AND AGRONOMICAL MODELS FOR PRECISION FERTILISATION IN ORGANIC OPEN FIELD VEGETABLE PRODUCTION

Introduction

Category: Research Innovation (RI)

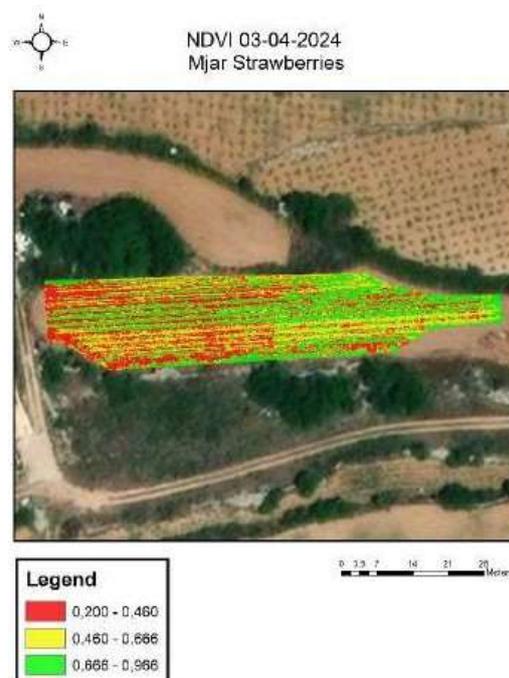
Practice identity card

#multispectral drone technology, crop health monitoring

#PF / food /broccoli / RI / Greece

Short description

- ➔ The practice involves integrating advanced precision farming technologies, including multispectral drone imaging, IoT soil and environmental sensors, and agronomical models, to optimize fertilization in organic open-field broccoli production. Unlike traditional fertilisation methods commonly used in Greece, which rely on the broadcast application of organic inputs like compost or manure, this practice employs real-time monitoring to address nutrient variability within the field. Conventional methods often lead to inefficiencies, such as uneven nutrient distribution, overuse in some areas, and deficiencies in others, impacting yield and environmental sustainability. By contrast, this innovation enables precise, site-specific nutrient application tailored to crop needs.
- ➔ This innovative approach combines real-time monitoring with data-driven decision-making to ensure precise nutrient application based on the crop's specific needs. Multispectral drones fly over fields, capturing high-resolution imagery of broccoli fields to identify areas of nutrient deficiency, plant stress, or uneven growth patterns. IoT sensors installed in the soil and surrounding environment provide continuous data on soil nutrient levels, soil moisture content and temperature, and other environmental conditions. Together, these technologies provide a comprehensive dataset



that agronomical models analyze to create actionable insights, such as fertilization schedules and application rates tailored to each field zone. Farm Management Software (FMS) consolidates the data and facilitates decision-making by delivering clear, actionable recommendations to farmers.

- ➔ This innovation addresses key challenges in organic broccoli production by improving resource efficiency, minimizing nutrient leaching, and maintaining soil health. By preventing over-application of fertilizers, the practice reduces the risks of nutrient runoff into water bodies and supports better nutrient cycling. Additionally, avoiding excessive nutrient concentrations fosters healthy soil microbiomes, which are crucial for sustainable organic farming. These benefits extend to long-term productivity, making the practice particularly suited for crops like broccoli, which have high nutrient demands and spatial variability.
- ➔ One of the standout benefits of this practice is its ability to provide immediate, actionable insights that save time and resources for farmers. For instance, multispectral drone imaging can detect nutrient deficiencies or stress in broccoli crops weeks before they become visually apparent, allowing farmers to take corrective actions early and avoid potential yield losses. IoT sensors continuously monitor soil conditions, meaning farmers no longer need to rely on periodic soil tests, which can miss critical changes during the growing season. This real-time feedback enables precise interventions, such as applying organic fertilizers only where and when they are needed, reducing input costs and ensuring optimal crop health. Additionally, the integration of FMS streamlines operations by consolidating all data into an easy-to-use platform, making decision-making faster and more informed. These practical advantages, combined with measurable savings on inputs and improved yields, make this practice an invaluable tool for modern organic farming.
- ➔ To sum up, the aim of the practice is to improve nutrient efficiency, increase yield and quality, and reduce the environmental footprint of fertilization practices in organic broccoli farming. By targeting fertilizer applications to areas of need, the practice minimizes waste, prevents nutrient leaching, and supports sustainable production.

Implementation process

Which practice is considered as the standard in this region? The standard practice in Greece, for fertilization in organic open-field vegetable production is a broadcast application of organic fertilizers such as compost, manure, or bio-based fertilizers, without precise targeting based on real-time monitoring. Nutrient application is often based on general recommendations or historical experience rather than real-time field conditions or crop-specific nutrient demands. Farmers may use periodic soil testing to guide fertilization decisions but lack access to advanced technologies like multispectral cameras, drones, IoT sensors, or agronomical models for precision nutrient management. This conventional approach, while suitable for organic farming regulations, often leads to inefficiencies, including uneven nutrient distribution, overuse in some areas, and nutrient deficiencies in others, ultimately impacting yield and environmental sustainability.

Logistics

- **Logistic aspects to consider:** First, equipment availability and setup is crucial, including drones equipped with multispectral cameras, IoT soil sensors, and the necessary software for data integration and analysis. Ensuring that these technologies are compatible and functional under local field conditions, such as varying weather conditions or soil types, is essential. Regular maintenance of equipment and sensors is also required to avoid disruptions during critical growth stages of broccoli. Another important consideration is internet connectivity and data

management, as IoT sensors and drone data often require reliable internet for real-time transmission and processing, which can be challenging in rural areas. Additionally, the training of personnel is critical, as farmers or operators must be skilled in using the drones, installing and maintaining sensors, and interpreting agronomical recommendations based on the data collected. Finally, the practice requires careful scheduling and planning to align drone flights, sensor readings, and fertilisation interventions with the growth stages of broccoli. Field access and mobility are also important, particularly in larger or fragmented fields, to ensure effective monitoring and targeted application.

- **Other specific tools involved/included:** The proposed RI involves the implementation of multiple tools at the farm, including drones with multispectral cameras, IoT soil and environmental sensors, and agronomical models. These tools work in an integrated system to provide real-time data and actionable insights for precision fertilization. The connection between these tools is generally good, as the technologies are designed to complement one another and share data seamlessly through farm management platforms or decision-support systems. However, the effectiveness of the connection depends on the compatibility of hardware and software, as well as the availability of reliable internet and power sources. For example, data collected by drones and IoT sensors must be processed and analyzed in tandem, and any lack of integration between these systems could create inefficiencies. When well-integrated, the use of these tools enhances the precision and efficiency of nutrient management. If not properly configured, challenges such as data silos or delays in decision-making could arise, potentially reducing the effectiveness of the practice.
- **Additional requirements for application:** Additional requirements include access to appropriate hardware such as multispectral drones, IoT sensors, and compatible agronomical software for data integration and analysis. Reliable internet connectivity is often necessary for real-time data transmission, and sufficient power infrastructure is required for charging devices and running processing equipment. Farmers must also ensure compatibility between different tools and invest in regular maintenance. Training for personnel in operating drones, setting up sensors, and interpreting agronomical recommendations is essential for successful implementation.
- **Skill/education level required:** Expert level

Agronomical traits

- **Can the practice be applied to a multitude of cultivation techniques?** The practice can be applied broadly to open-field cultivation techniques, especially those used in organic vegetable production. However, it is particularly suited to crops with high nutrient demands and spatial variability, such as broccoli. It is less applicable to highly controlled environments like hydroponics or vertical farming, where other monitoring systems are more suitable.
- **Targeted crop categories:** food
- **Influence on soil quality:** By optimizing fertilization based on real-time site-specific data, the practice prevents overapplication of nutrients, reducing risks of nutrient leaching and soil degradation. Additionally, targeted fertilization promotes better nutrient cycling in the soil, maintaining or improving soil fertility over time. It can also support the microbial health of the soil by avoiding excessive nutrient concentrations, particularly in organic farming systems.
- **Suitable soil types:** peaty, sandy, clay, loamy, chalky, silty
- **Expected effect on crop yield:** increase
- **Expected effect on crop yield variation:** decrease
- **Expected effect on crop quality:** increase
- **Expected effect on crop quality variation:** decrease
- **Which costs may increase due to the practice?** skilled labour, equipment, internet / data

subscription costs, energy

- **Which costs may decrease due to the practice?** fertilizers, pesticides, fuel, unskilled labour
- **Expected long-term/indirect economic benefits of the practice:** The practice offers significant long-term economic benefits, including increased crop yield and quality, which boost profitability. By optimizing fertilizer use, it reduces input costs over time and minimizes environmental compliance expenses, such as mitigating nutrient runoff. Improved soil health and resource efficiency contribute to sustained productivity and reduced degradation risks. Additionally, the use of advanced technologies can enhance market competitiveness, attract investment, and increase access to subsidies or certifications for sustainable farming practices.
- **Expected effect on the leaching of nutrients:** The RI is expected to decrease the leaching of nitrogen, phosphate, and potassium. By using precision data from drones and IoT sensors, fertilisation is optimized to meet the actual needs of the broccoli crop. This minimizes overapplication, reducing the runoff of excess nutrients into the soil and surrounding environment.
- **Specific materials applied through the practice:** animal manure, compost, plant extracts

Administrative context

- **Does the practice qualify for subsidies?** The practice may qualify for subsidies under EU initiatives such as the Common Agricultural Policy (CAP) that support precision agriculture and sustainability. Programs targeting innovation, environmental stewardship, and resource efficiency, especially in organic farming, are likely to provide financial support. Farmers should check regional and national funding schemes specific to their location and crop type.
- **Status of the legal framework that regulates the practice:** existing, however with gaps
- **Are there any policy barriers complicating the practice's application?** Policy barriers include strict drone regulations, such as licensing and restrictions in agricultural airspace. Additionally, unclear guidelines for handling IoT-collected data in compliance with privacy laws and a lack of specific provisions for combining organic farming standards with precision technology pose challenges. Subsidy frameworks may also favor traditional practices, slowing adoption.
- **Does the practice involve the use of hazardous substances?** No
- **Is the practice supported by Eco-schemes?** The practice aligns with Eco-schemes under the EU's Common Agricultural Policy (CAP), as it promotes sustainability, resource efficiency, and environmentally friendly fertilization practices. These objectives match the goals of Eco-schemes supporting organic and precision farming innovations.
- **Are there any gaseous emissions to be considered upon application of the practice?** yes: nitrous oxide, yes: ammonia
- **Greenhouse gas (GHG) reduction potential of the practice:** substantial
- **All features of the practice than may hinder its social acceptance:** noise, concerns about data breaches, not applicable
- **Expected effects from the practice on the time occupation of the farmer?** time-saving
- **May the practice contribute to a better public image of agriculture?** The practice can contribute to a better public image of agriculture by demonstrating the adoption of sustainable, innovative, and efficient fertilization methods. It highlights the sector's commitment to reducing environmental impacts through precision technologies and improving the quality and sustainability of food production. These advancements can enhance consumer trust and confidence in modern farming practices.
- **May the practice improve the farmer's self-image?** The practice may significantly improve the farmer's self-image by showcasing their adoption of cutting-edge technologies and sustainable practices. It reflects their commitment to innovation, environmental stewardship, and producing

high-quality crops, which can foster pride in their role as forward-thinking agricultural professionals.

- **Other relevant information:** The integration of precision technologies like drones and IoT sensors not only boosts productivity but also positions farmers as leaders in sustainable agriculture. Such practices can help bridge the gap between traditional farming and modern technology, enhancing the perception of farming as a high-tech, progressive profession while also contributing to environmental goals and consumer satisfaction.

Contact

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Eu member state: Greece

Find out more

Source of information SMARTAGRIHUBS PROJECT: FIE#26 <https://www.smartagrihubs.eu/flagship-innovation-experiment/26-fie-digitising-open-field-vegetables>
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