2023

i9Kiwi

Making the kiwifruit industry more sustainable while creating a value-added product.

EAFRD-funded projects

Location: Coimbra, Portugal

Programming period: 2014-2020

Priority: P4 – Ecosystems management

Focus Area: Biodiversity restoration, preservation & enhancement

Measures: M16 – Cooperation

Funding:

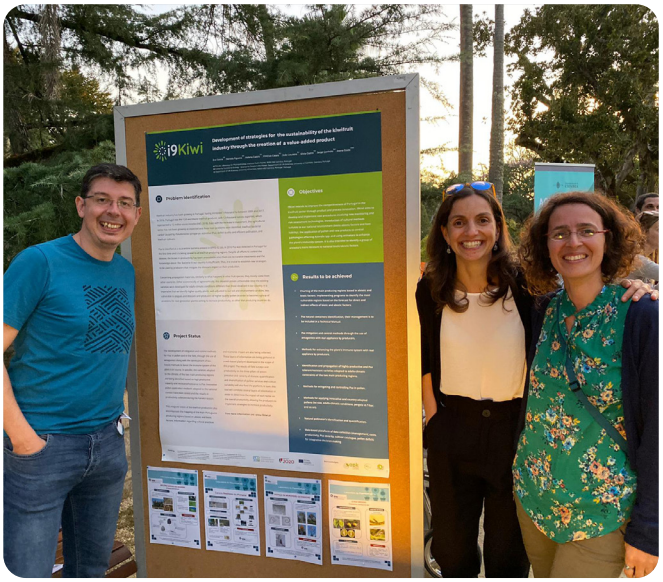
Total budget	417 409.93 (EUR)
EAFRD	281 296.80 (EUR)
National/Regional	31 896.97 (EUR)
Private/Own funds	104 216.16 (EUR)

Timeframe: 2017 to 2021

Project promoter: INSTITUTO PEDRO NUNES
The Project promoter/beneficiary is an EIP-AGRI Operational Group.

Email: jcdcosta@ipn.pt, info@ipn.pt

Tel: +351 239 700 920



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Summary

The project was designed to map the main kiwifruit-producing regions in Portugal and to identify the most vulnerable ones based on a prediction of the direct and indirect effects of abiotic and biotic factors. The main tasks were to identify key factors such as Pseudomonas syringae pathovar actinidia (PSA) bacteria mitigation and control methods, natural PSA reservoirs, methods of boosting the kiwifruit plant's immune system, and varieties that are adapted to the soil and climate constraints of the two main producing regions in Portugal, Entre Douro e Minho and Beira Litoral. The project also studied innovative pollen application methods adapted to the national context (plot size, soil and climate conditions, pergola versus crosspiece etc.).

i9Kiwi has improved the country's competitiveness, focusing exclusively on primary production activities in the kiwi sector through product and process innovation amongst other aspects.

Project results

- Increase in production
- Significant reduction in the use of phytopharmaceuticals by changing plant protection practices (e.g. hygienic pruning, disinfection of material, certification of propagating material, analyses of soil and irrigation water)
- A network of sensors and monitoring provided by the i9Kiwi platform made it possible to optimise pesticide and fertiliser use, thus reducing water and energy consumption and costs
- Growers received advice given on the best areas to plant, care to be taken before planting and the most suitable varieties, thus optimising resources
- Promotion of climate change adaptation, resilience, biodiversity, agroecological and more sustainable practices, local products, conversion to organic farming, optimisation of resources, reduction in carbon footprint
- The project promoted the sector's digitalisation and literacy on sustainability, resilience and agri-environmental practices

Key lessons and recommendations

- Align the objectives of the project with the real needs of the industry
- Involve producers in all activities, communicate results frequently
- Participate in and organise technical activities dedicated to the sector and tailored to its needs
- Actively seek ways to transfer knowledge and raise awareness about future challenges
- Have faith in producers, who were willing to participate in the various activities and carry out the tasks to completion, even during the COVID-19 pandemic

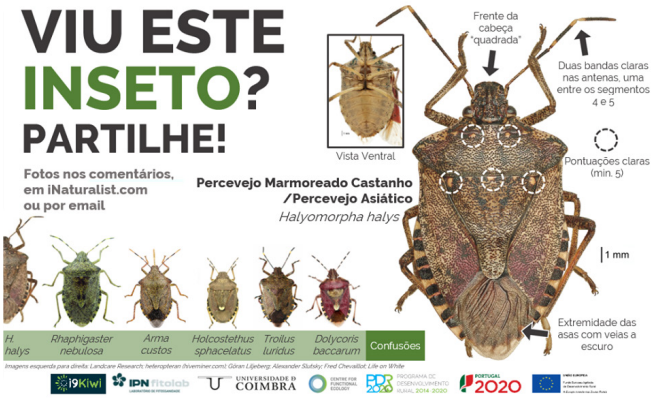
Context

Kiwifruit production is a significant global economic activity, particularly in Portugal, where it is the fastest-growing agri-food sector. The two main producing regions are Entre Douro e Minho and Beira Litoral, which feature high production capacity and resistance to PSA-induced diseases.

Despite ongoing investments, however, productivity has not met expectations due to issues related to plants' resilience, health and pollination. The lack of technical knowledge among producers, coupled with the absence of smart, tailored and competitive precision agriculture solutions, poses constraints to the economic, environmental and social sustainability of the sector.

The EIP-AGRI Operational Group i9Kiwi emerged as a response to these constraints through a partnership of scientific and technological institutions. This collaboration achieved tangible results and facilitated innovation transfer in the sector, impacting productivity and production costs.

i9Kiwi identified a dominant population of *Pseudomonas syringae pathovar actinidia* (PSA), a bacterium linked to severe diseases, and comparative genomics revealed genetic determinants related to virulence and environmental persistence. The project identified functional groups of bacteria and fungi with biotechnological potential for disease control and health promotion. Eight new species (one of bees, four of bacteria and three of pseudomonas) were studied, two of them with a potential phytosanitary impact. In parallel, orchard insect and pollinator communities were studied, revealing variable deficits in pollination over time and space. Local practices promoting pollinator communities were encouraged by the project and benefited productivity, with the honeybee as the primary pollinator due to its abundance in the territory.



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Objectives

The project looked at three main objectives: diseases associated with production and innovative solutions against PSA *(Pseudomonas syringae pathovar actinidia)*; pollination: phenology, viability, and pollen application; and monitoring biotic and abiotic factors.

This EIP-AGRI Operational Group aimed at studying the characteristics of the PSA population, identifying virulent strains and their determinants and studying their impact on the kiwifruit phyllosphere microbiota (the microorganisms living on the aerial region of the plant). Other key activities included compiling a collection of beneficial microorganisms found in kiwifruit orchards with biotechnological applications, investigating communities of pollinating insects, and assessing pollen availability for effective pollination practices.

Away from the field, the group needed to develop a decision support platform, customised for the kiwifruit sector, incorporating data from wireless sensors to aid in agricultural practices and pest management.

The combination of these theoretical and practical elements would help to promote plant health and biodiversity out in the orchards, as well as the development of a good practice guide for current and future reference.

Activities

Several field trials were selected according to the project objectives.

In order to identify diseases associated with production and innovative solutions against PSA *(Pseudomonas syringae pathovar actinidia)*, four kiwi *(Actinidia deliciosa)* orchards were chosen based on region, age, severity of PSA, and plant variety. The orchards were sampled during spring and autumn, different types of PSA bacteria were isolated and their genetic material was studied and compared (using the Illumina HiSeq platform), identifying virulence factors. The genetic material of microbiota living on the phyllosphere (aerial part of the plants) of healthy and diseased kiwifruit plants was also studied to evaluate their potential antagonism against PSA and other kiwifruit bacterial diseases. Simultaneously, growth promotion was tested.

Controlled pollination experiments and insect and pollinator monitoring were conducted in 23 orchards over two years, covering the entire kiwifruit production area in Portugal. Additionally, the efficiency of pollen application was evaluated in seven orchards. Nine fruit characteristics were assessed and weight was used to calculate pollination deficits, relating them to pollinator diversity, abundance and environmental variables. Production values, fruit size and market values were used to calculate the economic impact of pollination deficits and pollen application. Insect and pollinator communities were measured through direct observations, networks and a community science project involving producers, with monthly sampling over 12 months.

During the project, wireless sensor networks were applied in seven orchards to analyse abiotic parameters such as leaf humidity, solar radiation, atmospheric pressure, wind direction and speed, soil humidity, air temperature and humidity, and bioclimatic indices including the number of cold hours in a given period. Sensor data was sent to the i9Kiwi platform, processed and analysed by a rules engine, generating real-time alarms for data outside pre-defined parameters as well as a set of bioclimatic indicators. The platform facilitated recording orchard interventions and monitored specific factors such as phenology, diseases and insects. Data recording forms were designed and implemented with input from project partners, optimising them for kiwifruit diseases, pests and agricultural practices.

The dissemination, communication and demonstration activities of i9Kiwi were tailored to the target audience and divided into various categories, including publishing scientific and technical articles, participating in events to disseminate results, organising demonstration actions, technical workshops and congresses to share project results, conducting awareness and demonstration activities for the general public, and producing and disseminating a technical manual with management measures.

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Main results

i9Kiwi's work led to an overall increase in production, with a significant reduction in the use of phytopharmaceuticals. This was achieved by changing cultural practices related to plant protection such as hygienic pruning, disinfection of material, certification of propagating material and analyses of soil and irrigation water.

The network of sensors and monitoring provided by the i9Kiwi platform has also facilitated a reduction in water and energy consumption and optimisation of the use of pesticides and fertilisers, thereby reducing costs.

Based on the information generated on the severity and incidence of diseases, the group was able to advise growers on the best areas to plant, the care to be taken before planting the orchard and the most suitable varieties of plants, thus optimising the resources allocated.

Overall, the project has contributed to climate change adaptation and resilience, promoting biodiversity as well as agroecological and more sustainable practices and local products, supporting the ongoing conversion to organic farming, optimising the

use of resources and reducing carbon footprint. Furthermore, it promoted the digitalisation of the sector and producers' literacy on sustainability, resilience and agri-environmental practices.

i9Kiwi's participation in technical meetings organised by the sector, to share the project's progress and discuss issues relevant to the sustainability and resilience, created a very broad collaborative network. This remains active through joint participation in events, advice to producers and the presentation of projects. The regular publication of technical articles and the organisation of workshops also make it possible to transfer knowledge across the sector.

Key lessons and recommendations

Beyond the scientific and technological challenges, the most interesting aspect of i9Kiwi was the creation of a platform based on collaboration and trust, aligning the objectives of the project with the real needs of the industry. Producers were involved in all activities through frequent communication of results and the organisation of dedicated technical activities tailored to the sector's needs. The project actively sought ways to transfer knowledge and raise awareness about future challenges and implemented a citizen science project with producers from different backgrounds and skills.

Finding producers who were willing to participate in the various activities and carry out the tasks to completion was easy. A very positive aspect was the growers' commitment even during the COVID-19 pandemic, when they provided continued access to the fields and took part in the online activities organised by the project.

Additional information:

i9kiwi project website:
https://i9kiwi.pt/

Polli.net website:
https://www.pollinet.pt/

Cultivar Program website:
https://icultivar.pt/

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