DOSSIER TÈCNIC
TRAINING AND ADVICE FOR THE AGRI-FOOD SECTOR

N95

OPERATIONAL GROUPS IN CATALONIA
2015 CALL

P03 European Innovation Partnership EIP-AGRI: implementation at the European level of the Cooperation for Innovation Measure P05 Cooperation for Innovation: funding opportunities for the agri-food and forestry sector P08 Innovative pilot projects of the Catalan Operational Groups. 2015 Call P30 Interviews with members of the Operational Groups from the 2015 call P32 Map of the 2015 Operational Groups

February 2019

Rural Cat

Generalitat de Catalunya
Departament d'Agricultura, Ramaderia, Pesca i Alimentació
http://agricultura.gencat.cat

INTRODUCTION

Carmel Mòdol i Bresolí
Director General for Food, Quality and Agri-food Industries

The agri-food and forestry sector is of great strategic importance to the Catalan economy. Stimulating innovation and applying the results of research programmes are key to improving its competitiveness.

Innovation in the agri-food sector is a transversal priority in the EU's objectives, because it helps promote a resource-efficient, productive and low-emission sector that guarantees the sustainable development of rural areas.

The Government of Catalonia's interdepartmental Strategic Plan for Agri-Food Research, Innovation and Knowledge Transfer 2013–2020 was devised to foster the productive economy and sustainability of the agricultural and agri-food sector and the rural environment in general through innovation in alignment with the main policies related to the European Union's 2014–2020 innovation programme.

This strategic plan aims to improve the governance of the R&D&I system and establish mechanisms for the coordination and cooperation of R&D&I efforts between local governments. It is based on cooperation between all the agents involved and especially affects the creation of the spaces necessary to foster innovation with the aim of helping companies identify their needs, difficulties and opportunities and creating a favourable environment in which the sector can access and adapt knowledge and technological solutions.

The plan sets out six strategic objectives and 42 lines of action designed to improve the competitiveness and sustainability of the agri-food and forestry sector.

One of the objectives of the strategic plan is to increase the resources available to the R&D&I system of Catalonia's agri-food and forestry sector. To meet this objective, the Operational Group grants were created as an innovation instrument within the framework of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) with funding in the amount of 17.6 million euros.

The Operational Groups are groups formed by various organisations, companies and agents to solve a specific sectoral or territorial problem or to take advantage of a specific opportunity. The members of these groups may include agricultural, agri-food or forestry companies and industries, cooperatives, agricultural producer groups, universities, research centres, consultants, technology companies, non-agricultural SMEs, NGOs, and other supply-chain agents. The Operational Groups constitute an instrument of innovation that enables the sector to solve specific problems or take advantage of opportunities arising from collaborative work. They also strengthen synergies and establish complementarities between the various universities, research centres and professionals that operate in the agri-food, forestry and environmental spheres and foster their specialisation.

Catalonia announced its first Operational Group call for applicants in August 2015. It was one of the first European regions to take this measure. Catalonia was also the first European region to hold a second call, in 2016. As of 2018, the DARP has assigned a total budget of 15.5 million euros to projects in a variety of areas within the agri-food and forestry sector. Some 41 Operational Groups have completed the creation and proposal phase of their innovative projects, while 22 have completed their pilot projects and a further 57 are developing them.

The aim of this *Technical Dossier* is to report the results achieved by the Catalan Operational Groups that have implemented innovative pilot projects within the framework of the 2015 call. The projects foster innovation, cooperation and knowledge development in rural areas and strengthen ties between agriculture, food production and silviculture and research and innovation, and they also improve environmental management and performance.

Finally, we would like to take this opportunity to express our appreciation for the work done by everyone involved in agri-food and forestry R&D&I. We encourage all actors in the supply chain to continue their collaborative work and make progress to build on the Catalan agri-food and forestry sector's strength, competitiveness and leadership through the creation of knowledge and the generation of wealth and added value.

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Cover photo:
Winter dew in cereal fields.By: Ricard Poch Massegú

Introduction photos:
Photos contributed by various Operational Group members.

EUROPEAN INNOVATION PARTNERSHIP FOR AGRICULTURAL PRODUCTIVITY AND SUSTAINABILITY (EIP-AGRI): IMPLEMENTATION AT EUROPEAN LEVEL OF THE COOPERATION FOR INNOVATION MEASURE

Figure 1. *EIP-AGRI workshop. Source: European Commission.*

01 Introduction

Research and innovation are essential to meet the socio-economic demands of our age. Accordingly, they are amongst the central elements of the Europe 2020 strategy for growth and employment. Europe 2020 indicates smart, sustainable and inclusive growth as the path to overcome the European economy's structural deficiencies and improve its competitiveness and productivity.

02 European Innovation Partnerships (EIPs): an interactive innovation model

One of the emblematic initiatives included in Europe 2020 is the Innovation Union, whose objective is to improve research and innovation conditions and access to funding in order to ensure that innovative ideas become products and services that generate growth and employment. The Innovation Union includes the implementation of European Innovation Partnerships (EIPs), a new approach that brings together the parties involved in innovation (farmers, technical consultants, researchers, companies, NGOs, etc.) and helps bridge the gap between research and practice. In order to meet their objective of maximising the impact these projects have on the territory, the EIPs are based on two fundamental ideas: actions aimed at solving specific problems and taking advantage of opportunities for end users; and projects jointly developed by groups of people whose knowledge may be complementary (e.g. scientific and practical). This ensures that the activities developed in each of the projects are carried out jointly, combining the efforts of all the partners in every phase, from definition through to execution. This approach is the "interactive innovation model" and it is essential to successfully meet today's complex challenges. In summary, to paraphrase Woodrow Wilson, the 28th president of the United States and Nobel Peace Prize laureate, we need all the brains we can get.

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An interactive innovation model is essential to successfully meet today's complex challenges.

03 The European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI)

Specifically, the partnership dedicated to the agricultural sector (EIP-AGRI) works to strengthen the competitiveness and sustainability of the agricultural and forestry sectors in order to achieve better results with fewer resources. Accordingly, the EIP-AGRI applies the principle of interactive innovation and fosters Agricultural Knowledge and Innovation Systems (AKISs) , the concept used on the European scale to describe how people and organisations are brought together to promote mutual learning and to generate, share and use knowledge and information related to agriculture on the national or regional scale. But the EIP-AGRI also stimulates and encourages exchanges (meetings, workshops…) on the European scale between the members of the various AKISs to help agricultural innovations be quickly disseminated throughout Europe. The post-2020 Common Agricultural Policy (CAP) proposes the inclusion of strategic plans designed to increase the potential of these AKISs.

The EIP-AGRI applies the principle of interactive innovation within the framework of European research funding and the CAP's rural development

We hope to achieve numerous benefits from these interactive projects thanks to their ability to develop innovative and easily applicable solutions.

policy. The European Union's innovation policy (the current framework programme is known as Horizon 2020) is executed through a multi-actor approach, to which one million euros is allocated for this programming period. The rural development policy is executed through the EIP's Operational Groups.

04 The Operational Groups: an instrument for innovation within the rural development policy

The Operational Groups are groups of people who work jointly on an innovation project funded by the Rural Development Programmes (RDPs). They are the main tool of the EIP-AGRI to materialise and visualise the AKISs and ensure that innovative ideas become actual solutions. Successfully configuring and implementing an Operational Group requires a good innovative idea, the right partners, a solid plan and effective means of disseminating the results.

Each Operational Group carries out a project and is formed by the key actors (farmers, consultants, researchers, companies, NGOs, etc.) in the best position to achieve the objectives of the project, share implementation experiences and disseminate the results in general terms.

Some 3,200 Operational Groups are expected to be created in the European Union (97 RDPs in the 27 Member States) in the period from 2014 to 2020. It is estimated that 25 to 30% of them have already been created. Of these groups, 852 would be in Spain, making it the leading state in the implementation of this measure. Catalonia was one of the pioneering European regions in the organisation of Operational Group projects, thanks to its experience managing and stimulating the AKISs. With regard to the subjects covered, in addition to agricultural production (arable and livestock), the following areas stand out: soil, water, climate, waste, pest/disease and nutrient management, biodiversity, food processing, supply chain, and agricultural marketing and diversification.

We hope to achieve numerous benefits from these interactive projects thanks to their ability to develop innovative and easily applicable solutions that are better equipped to meet the actual needs of the public, which has been involved from the start. Moreover, the end users, including farmers, silviculturists and companies, will be more motivated to use the results of the projects as they have actively participated in their generation and as such feel invested in them. The aim is to optimise implementation of the results of the research. In the words of Thomas Alva Edison, the inventor of the light bulb: "The value of an idea lies in the using of it."

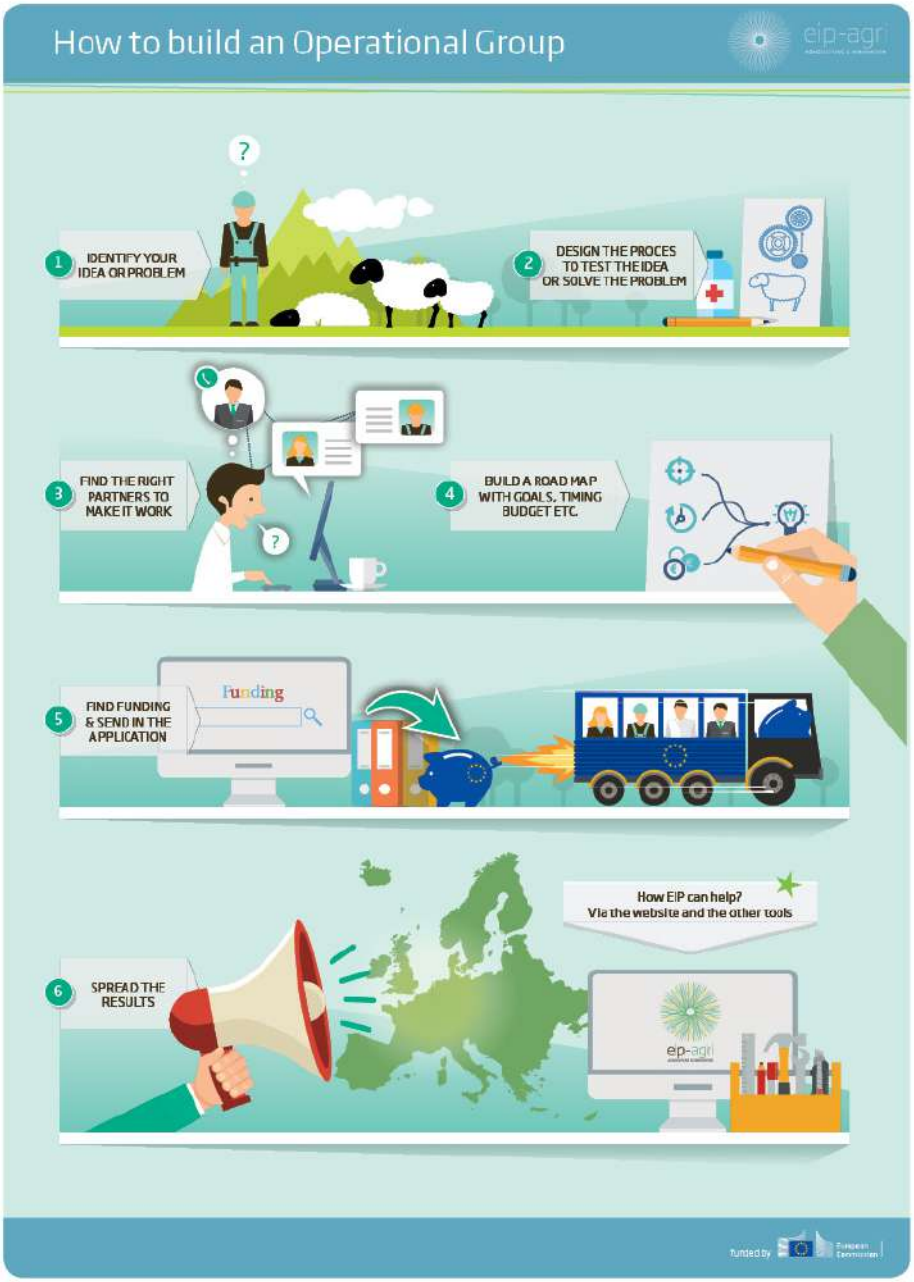

Figure 2. *Page from an explanatory leaflet on the Operational Groups. Source: EIP-AGRI.*

05 Further reading

Europe 2020 strategy: https://bit.ly/2j5M4rB

European Commission, EIP-AGRI
https://ec.europa.eu/eip/agriculture/

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COOPERATION FOR INNOVATION: FUNDING OPPORTUNITIES FOR THE AGRI-FOOD AND FORESTRY SECTOR

Figure 1. *Cultivation of leguminous species in Gurb. Photograph: Ricard Poch Massegú.*

01 Introduction

Innovation is fundamental to foster an agri-food and forestry sector that is more efficient in terms of production and resource use and has a low level of emissions and at the same time guarantees the sustainable development of rural areas and an increase in the competitiveness and diversification of the sector. For this reason, innovation in the agri-food and forestry area is one of the priorities of both the Government of Catalonia and the European Union.

02 The Rural Development Programme Cooperation Measure

In line with this priority, one of the challenges of the 2014–2020 Rural Development Programme of Catalonia is to stimulate innovation and knowledge transfer in the agri-food and forestry sector. To meet this challenge, various measures are planned to foster training, knowledge transfer and innovation. These measures include the Cooperation for Innovation Measure, endowed with €17.6 million for the entire programming period of the 2014–2020 RDP of Catalonia. Of this budget, 57% was met by the Ministry of Agriculture, Livestock, Fisheries and Food (DARP) and the remaining 43% was met by the European Agricultural Fund for Rural Development (EAFRD).

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The Cooperation for Innovation Measure is materialised through grants earmarked for the creation and operation of Operational Groups, the main tool of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) to transform innovative ideas into actual solutions for the sector.

The Cooperation for Innovation Measure is materialised through grants earmarked for the creation and operation of Operational Groups, the main tool of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) to transform innovative ideas into actual solutions for the sector. The Operational Groups bring people with complementary knowledge together and their composition varies in accordance with the subject matter and the specific objectives of each project. Farmers, silviculturists, consultants, scientists, companies and other related collaborators work together to find solutions to the specific problems faced by the agricultural and forestry sector or to take advantage of a specific opportunity.

This innovation instrument aims to strengthen synergies and complementarities between

the various universities, research centres and agents in the sector that work in the agri-food, forestry and environmental spheres.

03 The Operational Groups

The Operational Groups identify a problem or design the steps necessary to test an innovative idea. Cooperation is a fundamental element of all Operational Groups, so it is important to build a competent team and prepare a good work plan to move forward with the project.

To form an Operational Group at least two actors that are independent of each other are necessary. Each Operational Group designates a leader to be responsible for applying for the grant. There is no limit on the number of members of an Operational Group, but there is on the number of members that can benefit from the grant (a maximum of five). Moreover, in the case of Operational Groups with at least two beneficiaries a project coordinator (not necessarily a member of the Operational Group) may be designated. This coordinator will be responsible for coordinating work, financial aspects and, in short, ensuring the development of the project. The composition of the Operational Group is included in a collaboration agreement signed by all the members.

All the Operational Groups work with a view to disseminating the results of the project, in such a way that others with similar challenges or problems can benefit from their knowledge. In addition to the dissemination work undertaken by each Operational Group and its publication in the EIP-AGRI, the DARP supports the dissemination of results by the Network of Agri-food and Rural Innovation of Catalonia (Xarxa-i.cat), a space —located in RuralCat and associated with the EIP-AGRI— to disseminate the results of collaborative projects, share knowledge on projects, find experts or partners for different types of innovation project...

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The Operational Groups identify a problem or design the steps necessary to test an innovative idea.

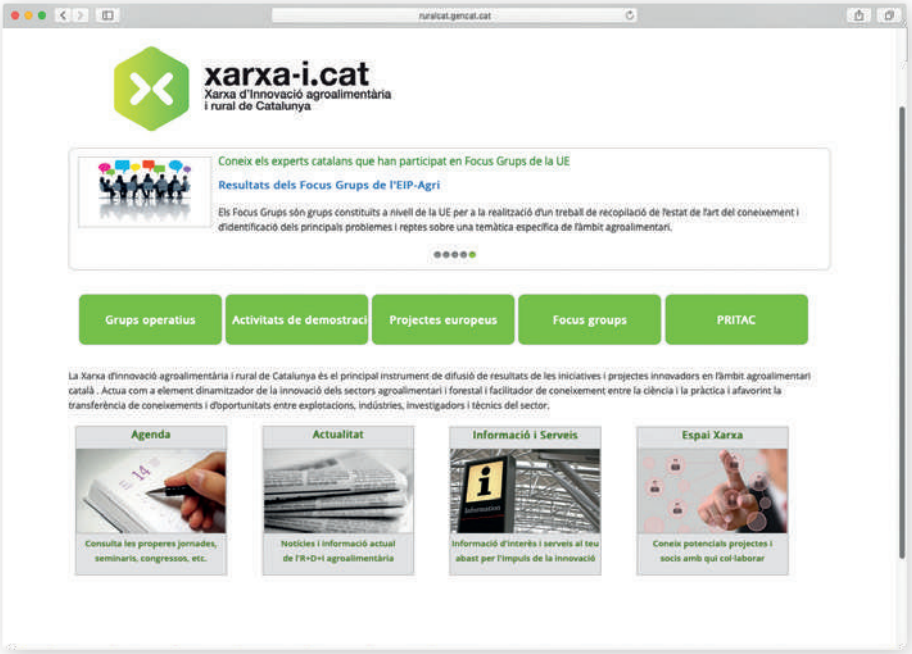

Figure 2. *The Network of Agri-food and Rural Innovation of Catalonia (Xarxa-i.cat) is a space located on the RuralCat portal, where the data of Catalan Operational Groups can be consulted. Source: DARP.*

04 Innovative projects

The projects that can be elegible for grants must be innovative and involve the execution of a common action by at least two independent actors. But, what is innovation understood to be? Innovation in the agri-food and forestry sector is a very broad concept, but in general terms it could be described as "a new idea that shows success in practice". In this sense, it may be the introduction of a product (good or service), process, sales or marketing method or organisational method into the internal practices of the company or its external relations. These changes must be new or represent a significant improvement with respect to the current products, processes or organisational structure of the company.

05 Grant modalities

The Cooperation Measure can provide economic support for the creation of an Operational Group and the definition of its project (innovative project proposal and drafting subsidy) or to meet the costs of a project of an Operational Group (innovative pilot project implementation subsidy).

05.01 Innovative project proposal and drafting subsidy

The aim of this is to defray the expense of creating an Operational Group and support the preparation of the innovation project. In this case, as the group has not yet been constituted, there will be a sole beneficiary per project, which will apply for the grant.

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The Cooperation Measure can provide economic support for the creation of an Operational Group and the definition of its project (innovative project proposal and drafting subsidy) or to meet the costs of a project of an Operational Group (innovative pilot project implementation subsidy).

The subsidy is for 70% of the expenses, up to a maximum of €10,000 per project.

05.02 Innovative pilot project implementation subsidy

These subsidies defray the expenses of implementing an innovative project of a constituted Operational Group through the realisation of a limited-duration experimental project that aims to validate products, practices, processes, technologies or services —new or improved— in an environment representative of the actual operating conditions (pilot project). To guarantee that there is a relationship between the productive sector and the research sphere, pilot projects must assign at least 20% of their expenses to hiring a technology or research centre or university.

CALL	PROPOSAL AND DRAFTING	PILOT	TOTAL
2015	€0.5 m	€3 m	€3.5 m
2016	€0.4 m	€3.1 m	€3.5 m
2017	€0.15 m	€3.85 m	€4 m
2018	€0.15 m	€4.35 m	€4.5 m
2019	-	-	€2.1 m
2014–2020 PROGRAMMING PERIOD	-	-	€17.6 m

Table 1. *Balance of the measure (millions of euros). Source: DARP.*

CALL	PROPOSAL AND DRAFTING	PILOT	TOTAL
2015	19	23	42
2016	14	23	37
2017	11	34	45
2018	-	-	-
2019	-	-	-
2014–2020 PROGRAMMING PERIOD	---	---	124

Table 2. *Balance of the measure (number of projects). Source: DARP.*

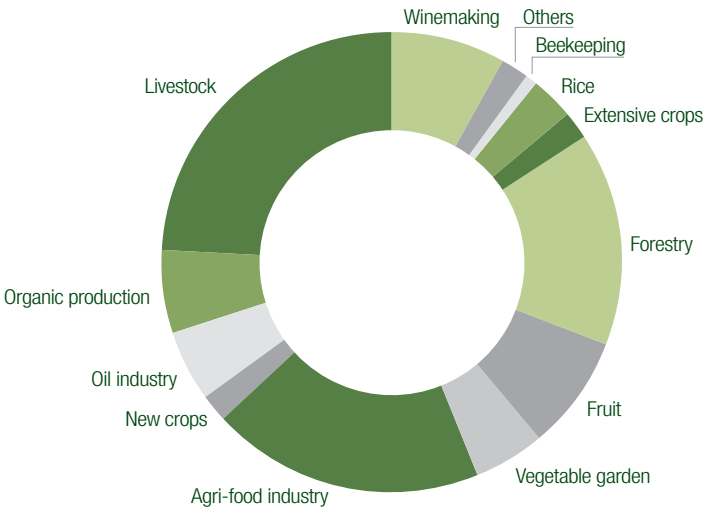

Figure 3. *Projects approved by sector (2015–2017). Source: DARP.*

The subsidy is for 70% of these expenses, up to a maximum of €140,000 per project. In the case of Operational Groups with more than two beneficiary members, this amount may be complemented with a grant for the coordination and stimulation of the project. The coordination subsidy is for a maximum of 6% of the project expenses, up to a maximum of €12,000. Therefore, the maximum amount per project is €152,000.

06 Assessment of the measure

Since 2015, the DARP has allocated a total budget of €17.6 million and a total of 124 projects have been approved in the annual calls (see Tables 1 and 2).

The success of the measure, which has been well received by the sector, has allowed the budget to increase with each call.

With respect to the subject matter of the subsidised projects (Figure 3), the most significant ones are those related to agriculture (42%) and livestock (24%), followed by the agri-food sector (19%) and finally the forestry sector (15%).

07 Further reading

Order ARP/133/2017, of 21 June, approving the regulatory bases of grants for cooperation for innovation through the promotion of the creation of Operational Groups of the European Innovation Partnership for Agricultural Productivity and Sustainability and the execution of innovative pilot projects by these groups (operation 16.01.01 of the 2014–2020 Rural Development Programme of Catalonia) (DOGC (Official Journal of the Government of Catalonia) no. 7399, of 27/06/2017).

Resolution ARP/1282/2018, of 8 June, organising the calls for applications for grants for cooperation for innovation through the promotion of the creation of Operational Groups of the European Innovation Partnership for Agricultural Productivity and Sustainability and the execution of innovative pilot projects by these groups (operation 16.01.01 of the 2014–2020 Rural Development Programme of Catalonia) (DOGC no. 7645, of 19/06/2018).

Rural Development Programme (RDP) of Catalonia for the 2014–2020 programming period: measure 16, operation 16.01.01, subsidies earmarked for cooperation for innovation: Operational Groups of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI).

RuralCat – Xarxa-i.cat website: http://ruralcat.gencat.cat/web/guest/pritac/portada.

RuralCat – Operational Group Search Engine: http://ruralcat.gencat.cat/web/guest/pritac/espai/cercador-grups-operatius.

EIP-AGRI network website: https://ec.europa.eu/eip/agriculture/en/about.

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INNOVATIVE PILOT PROJECTS OF OPERATIONAL GROUPS IN CATALONIA. 2015 CALL

IMPROVEMENT OF THE END LIPID PRODUCTS (FATS) OBTAINED FROM ANIMAL BY-PRODUCTS TO SUPPLY THE LOCAL LIVESTOCK SECTOR

Leader:	**Subproductos Cárnicos Echevarría y Asociados, SL**
Coordinator:	**Subproductos Cárnicos Echevarría y Asociados, SL**
Other members:	**National Association of Fat and Animal Product Processing Industries (ANAGRASA); Cal Cirera de Pinós, SL; Centre for Biotechnological and Agrofood Developments (DBA); Copecinter, SA**
Web:	**https://subcarnechevarria.com/ca/grups-operatius/**

Rationale

Clarified and "fine" fats are obtained in the treatment of animal by-products (ABPs) not intended for human consumption. In summer, due to the degeneration of raw materials, these fats are obtained in larger quantities and must be managed as waste. The objective of the project was to modify and improve the format of fats obtained from ABPs not intended for human consumption to achieve solid or semi-solid consistencies in the laboratory and in a pilot plant. In this way, the aim was to obtain a new product to directly supply small livestock farmers for the small-scale production of their own compound feed as caloric contribution and improve the traceability of animal feed. The rationale of the project is, therefore, the reuse of these end lipid products for their use in livestock feed within the framework of the circular bioeconomy.

The objective of this project was to improve the end lipid products (clarified fats) obtained from type 3 ABPs and supply them to the local livestock sector as an ingredient of compound feed. The improvement is based on the format of these products. Accordingly, the technical objectives were:

1. Obtain new and improved formats, with a solid or greasy consistency, from the lipid material from ABPs.

2. Study their palatability and nutritional value.

3. Optimise, on the pilot plant scale, the preparation process for the improved formats.

Results and conclusions

The activities were carried out and achieved the objective of obtaining on the small scale new formats of lipid products with a more solid consistency based on type 3 ABPs from the company Subcarn Echevarria. On the laboratory scale, the format of the fat can be improved to achieve a greasy consistency by means of mixtures of ABP:CaO (4% CaO) and solid consistencies through hydrogenation of the initial ABPs. On the scale of the pilot plant, a greasy fat is obtained from mixtures of ABP:CaO, the composition of which basically consists of triglycerides.

With these results it can be concluded that it is possible to extract and characterise the lipid material from the "fine fats" obtained in this type of industrial process and that this greasy fat with an improved consistency could be applied to the manufacture of compound feed on a small scale for local livestock farmers. The use of this new lipid material would improve livestock productivity, sustainability and resource efficiency within the framework of the circular bioeconomy.

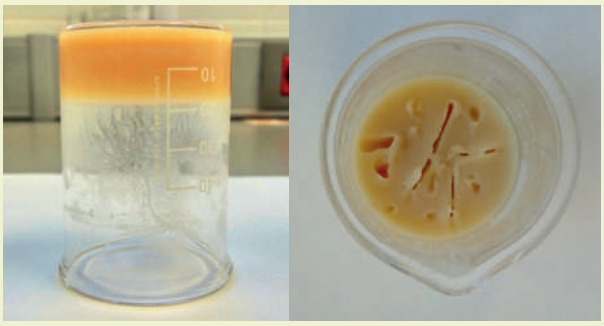

Figure 1. *Greasy solid obtained from ABP: CaO and water. Source: Subproductos Cárnicos Echevarria y Asociados S.L.*

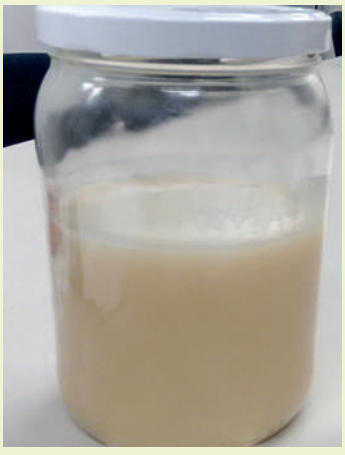

Figure 2. *Solid recovered after hydrogenation. Source: Subproductos Cárnicos Echevarria y Asociados S.L.*

CONTROL OF *MONILINIA* SPP. IN STONE FRUIT: USE OF PREDICTION MODELS AND PROPHYLACTIC METHODS

Leader:	**Actel, SCCL**
Coordinator:	**Institute of Agrifood Research and Technology (IRTA)**
Other members receiving aid:	**Agropecuària I SC de Soses, SCCL; Fruits de Ponent, SCCL**

Rationale

Brown rot caused by *Monilinia* spp. (*M. laxa, M. fructigena* and *M. fructicola*) is the main disease that affects stone fruit in our area and it causes serious losses in the field and in the post-harvest. It is one of the main causes of production and economic losses, and it is also a source of complaints from distribution chains. One of the characteristics of this disease is that during the harvest the fruit may not present symptoms even if it is infected by the fungus. This infection generally develops and, therefore, its symptoms appear, when the fruit reaches distribution and/or the end consumer, periods in which conditions for development of the fungus are optimal.

Currently, the main strategy to control *Monilinia* spp. in the field is based on programmes to apply synthesised fungicide products throughout the phenological stage of the crop. Notwithstanding, these treatments are not effective in years of weather which is highly favourable to the infection and the development of the disease, in which 80% or more of the fruit may rot. To control the disease in the stone fruit post-harvest, there are only two authorised active materials. The mass, continuous and in some cases uncontrolled use of synthesised chemical fungicides has generated a series of problems like the appearance of resistant fungal strains. In Spain, no resistant isolates of *M. laxa* had been detected until 2006, but recently strains of *M. fructicola* and *M. laxa* resistant to bencimidazoles and dicarboximides and of *M. fructicola* resistant to triazoles have been described. Moreover, the imposition of stricter restrictions on authorised active materials and maximum residue limits (MRLs) present in fruit and also the fostering on the European scale of the sustainable use of phytosanitary products are making it necessary to develop new *Monilinia* spp. control strategies. In accordance with the above, the main objective of this project was to improve the control of *Monilinia* spp. in stone fruit through the use of predictive models and the introduction of prophylactic measures.

Results and conclusions

The results have enabled the commercial validation of a risk prediction model for *Monilinia* spp. that has proven effective to reduce the number of treatments applied in the field to control this disease without increasing end losses. Moreover, the algorithm of the model has been automated and integrated into a viewer of climate data from a total of 9 agronomic stations connected in a network. In this way, the technicians can quickly and easily see whether there has been a risk of infection and decide whether a fungicide treatment should be applied. It should be stated that the main limitations on the use of this model are the need for an agronomic station at the farm and the requirement to take samples to determine the presence of inoculum in the field.

Figure 1. *Fruit affected by Monilinia spp. Source: IRTA.*

Figure 2. *Weather station located in a stone fruit field. Source: IRTA.*

The first limitation could be overcome if in the near future there is a network of stations in diverse microclimates, which would serve to extrapolate the data from one farm to another of the same type and, therefore, optimise the number of stations necessary. With regard to samples, the number to be taken is planned to be minimised in accordance with the rain forecast (considering that there is already inoculum in the plot, fungicide treatments would only be applied in accordance with the weather conditions).

The results of the project also show that there are not any strains of *Monilinia* spp. resistant to the chemical products currently applied to control them.

Other control strategies, such as the removal of inoculum from the farm around 10 to 15 days before the harvest, were found to be effective during the two-year project. However, it was not possible to conclude whether the treatments are more effective when applied before or after rain.

The results indicate that the final impact of the disease would be 3.6 times higher than that determined in the sample taken 7 days before the harvest, although they are not conclusive and more studies are necessary for confirmation.

Finally, it should be stated that the information generated in the project has been used to draft a guide on the disease in the field and post-harvest that includes the main conclusions of this project. This guide will help make peach and nectarine production for the most demanding markets more competitive by optimising phytosanitary treatments, improving their effectiveness and reducing their applications.

VINE PHYTOSANITARY TREATMENT REMOTE SENSING AND MANAGEMENT SYSTEM PILOT TEST

Leader:	**Sant Llorenç - Penedès Superior Plant Defence Group (ADV)**
Coordinator:	**INNOVI Association of Innovative Companies (AEI)**
Other members receiving aid:	**Sant Martí - Penedès Superior Plant Defence Group (ADV); Codorniu, SA; Gramona, SA**
Other members:	**Catalan Institute of Vines and Wines (INCAVI); Parés Baltà, SA**
Website:	**http://www.innovi.cat/sistemio**

Rationale

The project aimed to analyse and validate an effective and reliable vine management system to reduce the phytosanitary treatments applied to vines in Catalonia and orient the sector towards organic and sustainable agriculture by means of the Downy Mildew and Powdery Mildew Remote Sensing System (Sistemio). This system is designed to enable better vine planning and management and the reduction of phytosanitary treatments.

The main objective was the validation of the vine phytosanitary treatment management system, based on the collection of agro-environmental data on the plot scale and subsequent analysis using mechanistic epidemiological models.

This tool allows the winemaker to know at all times the epidemiological state of the plot and decide the right time to apply preventive treatments with the aim of maximising effectiveness and reducing the quantity of phytosanitary products used during the season.

The project installed 18 telemetry stations with ambient temperature, ambient humidity, rainfall and leaf wetness sensors programmed to send data every hour for two years.

The readings were processed by the Vite.net decision support system. The users can consult the results of the analysis remotely online. The system is configured with the characteristics of each plot (grape variety, soil characteristics…). These data are used to determine the optimal levels for the application of phytosanitary products in order to reduce their use. The system also makes predictions about when there will be infections and checks are made to determine whether they match actual infections and whether infections have been produced without being predicted.

Results and conclusions

The project was carried out in the planned conditions, enabling the Vite.net system to conduct its assessment with a view to monitoring vine diseases, especially downy mildew.

The system's control of powdery mildew is more complex, given that the presence of this fungus is practically permanent in our conditions. However, the system makes forecasts about the intensity of the pressure of this disease in accordance with the weather conditions, which have proven to be of great interest in the overall management of vine health.

The structure and presentation of the Vite.net system were viewed positively. The system includes the actual data obtained and a weather forecast as the basis for the prediction of fungal development, reproduction and dispersal. The information is presented in several well-structured blocks with the aim of providing as much information as possible to make treatment decisions:

- Development of the fungus, especially in the infective stages.
- Treatment conditions: period with biocide capacity according to the active matter applied.
- Treatment record.
- Meteorological data: historic, current and forecast.
- Map of observatories with a graphic system of warnings of risk periods.

The system also enables the introduction of user data, facilitating decision-making.

For downy mildew, the system forecasts possible periods favourable to infection according to the available data. Based on this forecast, it indicates the disease risk periods and intensities (as a basis for decisions on treatment application). When there is a period favourable to infection, the system verifies the viability of the announced infection.

Although the majority of predictions were confirmed, in some cases there were errors. These errors are due to variability in the development of the fungus associated with a diverse range of factors that, at certain times, may condition the criteria and algorithms upon which the Vite.net model is based.

Based on these results, it can be concluded that Vite.net is a precise and very useful tool for decision-making about the control of downy mildew, but its use requires a technical assessment that includes observation on the vine of the development of the fungus and its actual effect.

Figure 1. *Specific pilot meteorological station for the Sistemio project. Source: Tamic, SL.*

INTEGRATION OF BIOLOGICAL RESOURCES IN HORTICULTURAL PRODUCTION

Leader:	**Agrícola Maresme Segle XXI, SAT**
Coordinator:	**Institute of Agrifood Research and Technology (IRTA)**
Other members receiving aid:	**Agrícola de Vilassar de Mar, SCCL; Agrícola del Litoral, SCCL**
Other members:	**Baix Maresme Plant Defence Group (ADV); El Baix Llobregat Agricultural Park Consortium; Selmar; Catalan Union of Farmers (UP)**

Rationale

In order to foster more sustainable agriculture with a view to obtaining local market garden products with high added value and thereby improving the viability of farms, the project proposed actions aimed at taking advantage of natural resources, like useful indigenous fauna (biological control) and soil microorganisms (mycorrhizae), and rationalising the use of phytosanitary products and fertilisers in market garden crops.

The excess application of nitrogen fertilisers is one of modern agriculture's main problems and it leads to a reduction of soil microorganisms, which are responsible for breaking down organic material and biological control agents naturally found in the original soil. A low and reasonable application of fertilisers does not generate losses in the production or final quality of the product and, moreover, it can improve the natural fertility of the soil by incorporating funguses that form arbuscular mycorrhizae.

Apart from mycorrhization, the aim was to determine the effect of applying conservation biological control (CBC), taking advantage of useful indigenous fauna through the incorporation of permanent and temporary ecological infrastructure (EI) with plants that favour the presence of natural predators of pest species.

The specific objectives to be covered within the framework of this project were:

1. Assess the usefulness of permanent green infrastructure (borders) in CBC, in relation to size and surface area, in tomato and lettuce crops. Also assess the usefulness of this infrastructure in the biological control of other crops, such as onion and artichoke.

2. Prepare a method to use temporary green infrastructure (replacement plants) to transfer the predator *Macrolophus pygmaeus* between successive tomato crops.

3. Assess the usefulness of mycorrhizae in the establishment of borders of insect plants in green infrastructure.

4. Optimise the use of organic and mineral fertilisers in combination with funguses that form mycorrhizae.

The project included three pilot tests. The first pilot test measured the usefulness of borders in biological control in relation to size and surface area in fields of tomato and lettuce cultivated in the open air. The second pilot test assessed replacement plants (marigold) for the conservation of Miridae (plant bugs) in successive greenhouse tomato crops. The third pilot test tried to optimise fertigation through the incorporation of arbuscular mycorrhizae with proven effectiveness in the form of inoculum (produced at IRTA's facilities at the Cabrils centre).

Results and conclusions

The results show improvement in various aspects of the sustainable management of natural resources useful for horticultural production such as:

1. Agricultural biodiversity with the conservation of useful indigenous fauna in tomato, lettuce, onion and artichoke crops.

The establishment of permanent borders of marigold in open-air tomato fields favours the early colonisation of the predator *Macrolophus pygmaeus*. To favour colonisation, it is necessary for these borders to be kept in good condition with green and/or flowering plants. *Lobularia* plants located close to lettuce fields represent a source of attraction and food for hoverflies, which are the main natural enemies found in lettuces infested with aphids. The effect of the *Lobularia* border is weaker the further away it is from this food source. However, hoverflies have been found some 24 to 30 m from the border in lettuce fields. *Lobularia* located close to onion and artichoke fields do not reduce the number of plants affected by thrips and suckers. However, the proximity of these flowers helps concentrate and feed the hoverflies present in onion fields.

The establishment of permanent marigold borders in greenhouses enables the conservation of major populations of *Macrolophus* in winter. From these borders, *Macrolophus* is dispersed and established in spring crop tomatoes. The borders may be permanent in the case of small greenhouses or mobile with marigold plants in pots previously infested with *Macrolophus*. A number of 80 pots per ~1200 m^2 (1 pot/15 m^2) was sufficient to achieve the initial establishment of *Macrolophus*.

2. The management of fertilisers in tomato and onion: rationalise the contribution of fertilisers and mycorrhizae-forming funguses to face the problems of soil exhaustion with specific replant disease.

The application of less fertilisation in mycorrhized plants is an alternative to take into account to maintain a high level of total and commercial production of tomatoes and onions. This combination, which also favoured the quality and calibre of the fruit, reduces the contribution of nutrients and at the same time improves the microbiological quality of cultivated soil.

Figure 1. *Pilot Test 1. Activity 1.1. Plot prepared for tomato plants with an established border of marigold. Source: IRTA.*

STRATEGIES TO REDUCE NITROGEN EXCRETION IN FATTENED CALVES IN THE FINISHING STAGE

Leader:	**Corporació Alimentària Guissona, SA**
Coordinator:	**Alcarràs Cattle Entrepreneurs Association (AEBA)**
Other members receiving aid:	**Nanta, SA: Soluciones Integrales para la Nutrición Animal, SL**
Other members:	**Asoprovac Catalunya; Catalan Association of Feed Manufacturers (ASFAC); DARP - Soil and Environmental Management of Agricultural Production Service; Setna Nutrición, SAU**
Web:	**https://alcarrasbovi.com/2018/07/23/g-operatiu-2015-estrategies-per-reduir-lex crecio-de-nitrogen-en-vedells-dengreix-durant-la-fase-dacabat/**

Rationale

The ammonia emitted by livestock production is an air and water contaminant. Ammonia may be a precursor of N_2O, a gas that contributes to global warming, it may contribute to water eutrophication and soil acidification and it may form fine atmospheric particles that contribute to environmental contamination.

To prevent and reduce the water contamination caused by nitrates from agricultural sources, the project assessed the reduction of N excretion achieved with nutritional strategies to reduce the level of crude protein (CP) of the rations without harming growth and the conversion index (CI) in our intensive fattening system.

Specifically, the proposal was to work during the final stage of fattening with Friesian calves (the majority breed, with high consumption and low conversion) fed with high levels of concentrate. The tests were done with corn as the main cereal (representative of the feed prepared in Catalonia) and with granules (to increase the availability of starches at rumen level).

Three different nutritional strategies were studied with a focus on improving the efficiency of the use of N at rumen level. The effect on the following was assessed:

- Excretion of nitrogen in faeces and urine.

- Fermentation and rumen health.

- Consumption, growth and quality of the carcass.

To achieve this objective, controlled tests were carried out in an initial stage to assess N excretions and field tests were conducted in a secondary stage to validate the effect on growth in field conditions.

Results and conclusions

The results of this study indicate that, in the final stage, a 1% reduction in CP results in a 10% reduction in the excretion of nitrogen into the environment, without affecting the growth of the animal.

Although these are preliminary results, it should be mentioned that the tests carried out in vitro indicate that reducing the CP in the concentrates, that is, reducing N consumption, may also reduce the volatilisation of nitrogen during the manure storage phase.

Additionally, production costs can be reduced (cheaper formulas) and profits can be increased by €7.30/fattened calf (€179.8 - €172.4). This may represent a 1.5% reduction in the total cost.

Finally, although it is difficult to quantify, the ability to implement strategies that reduce environmental contamination can help transmit the sector's concern for the environment, improve its image and boost the veal consumption.

Question: When we reduce CP and the contribution of urea with the same level of starch, do we limit rumen? Growth?			
Treatments	**N1**	**N2**	**N3**
CP, as a % of FM	14.5	12.5	10.5
Soybean, %	10.8	7.5	4.2
Urea, %	0.6	0.3	
Starches, as a % of FM	41	41	41
Other ingredients:	40% corn, 8% barley, 10-12% wheat, 14-18% bran, 10-15% pulp, 2.6-3% palm oil, 1% calcium carbonate, 0.2% salt, 0.4% sodium bicarbonate, 0.15% magnesium oxide, 0.2% premix.		

Table 1. *Source: Operational Group.*

STAGE 1. A. Can we reduce the level of CP with the same level of starches?

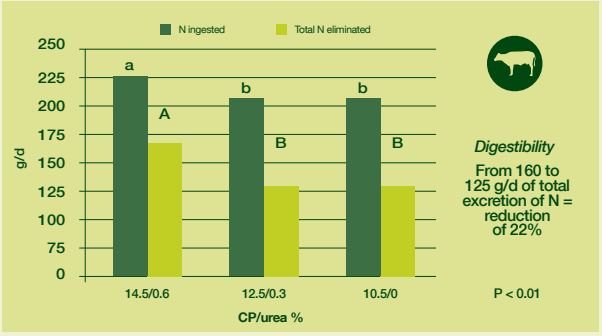

Figure 1. *Source: Operational Group.*

NEW STORAGE TECHNOLOGIES AND STRATEGIES FOR GOLDEN DELICIOUS AND VARIETIES OF THE GALA GROUP

Leader:	**Fructícola Empordà, SL**
Coordinator:	**Fructícola Empordà, SL**
Other members:	**A&F Agrària XXI, SL; Fruits Sant Pere, SL; Mas Badia Foundation**
Web:	**http://www.fructicolaemporda.com**

Rationale

The rationale of this Operational Group was to prepare new techniques to provide solutions for the fruit sector's need to improve the marketing of the Golden and Gala apple varieties.

The commercial demands of the Golden apple market have progressively moved towards a more intense yellow colour and firm pulp. This demand has made it necessary to change the productive process and the management of the variety in the Girona area, where the Golden apple varieties produced present a green tone. To meet these demands, the Operational Group analysed the viability of introducing apple degreening strategies to increase the colouring of the peel.

The Gala apple is highly valued by the market because of its attractive colour and taste. Its long preservation in cold storage is limited by the disease known as bruising disease or black spot (a spoilage condition related to the maturity of the apple that is not physiologically well understood). For this reason, the marketing of this variety is limited to a relatively short period of time. The Operational Group tested new preservation procedures with the aim of lengthening the apple preservation period in cold storage and minimising the internal darkening of the pulp.

The objectives of the project were:

– Assess various post-harvest fruit farming strategies to obtain Golden Delicious with a more intense yellow colour and with firm pulp after the storage period.

– Lengthen the preservation period of the Gala apple by applying new technologies and at the same time reduce the incidence of bruising disease.

Results and conclusions

Various degreening strategies were assessed for Golden Delicious and various storage systems were assessed for Gala in order to achieve the objectives of the project.

The degreening procedure that gave the best results was the application of high temperature (20ºC) and high humidity at the end of the storage period. Ethylene applications (in various doses) did not improve the result of the temperature. Low temperature thermal shock treatment did not improve the result either. Additionally, new yellow apple varieties, similar to Golden Delicious, were assessed as replacement options in new plantations. Those that stood out in terms of colour and taste were Opal and Honeymoon.

Accordingly, with regard to the degreening of Golden Delicious, the recommendations based on the data obtained from the various trials are:

– Treat the fruit to be degreened with 1-MCP (SmartFresh™) to prevent loss of firmness.

– Degreen apple batches with background colour >3; separate the fruit with the pre-calibrator into various batches according to background colour when leaving controlled atmosphere (CA) storage or plots with fruit that in the harvest have a background colour >3.

– Degreen with a maximum high temperature of 20ºC for at least 7 days.

– Thermal shock (alternating days of high and low temperatures) does not increase the colouring.

– Ethylene treatments at the end of storage do not increase colouring.

– Avoid high temperature treatments (20ºC) in the harvest because it increases the incidence of bitter pit.

Opal and Honey Moon stood out in the assessment of new varieties similar to Golden Delicious with a more intense yellow colour.

The Gala storage system that gave the best result was with in atmosphere with a low concentration of oxygen (0.4%) with the ACR (advanced control of respiration) control procedure. It allowed the storage period to extend to April, with a significant reduction in the incidence of bruising disease. The application of the 1-MCP product did not influence the results, but it did improve the firmness of the pulp. Delaying the introduction of the gases into the controlled atmosphere favoured the appearance of bruising disease.

Finally, with regard to Gala apples, the recommendations based on data obtained from the various trials are:

– The maintenance of very low levels of oxygen (0.4%) during the storage period significantly reduced the incidence of bruising disease.

– Treatment with 1-MCP does not influence the incidence of bruising disease, but it maintains the firmness of the pulp.

Figure 1. *Degrees of initial colouration of Golden Delicious (according to the Val Venosta card). Source: IRTA Mas Badia.*

Figure 2. *Example of treatment with ethylene assessed to improve the yellow colour of Golden Delicious. Source: IRTA Mas Badia.*

NEW METHODS AND TECHNOLOGIES TO PREVENT SPECIFIC REPLANT DISEASE IN APPLE TREES

Leader:	**Girona Fruits, SCCL**
Coordinator:	**Girona Fruits, SCCL**
Other members receiving aid:	**Baguda Fruits, SL (a Girona Fruits partner); Explotacions Agrícoles Bruguera, SL; Jordi Boix Llinàs (a Girona Fruits partner); Josep Creixell Tarrades, SC (a Girona Fruits partner)**
Other members:	**Mas Badia Foundation**
Web:	**http://gironafruits.com/nous-metodes-tecnologies-evitar-sindrome-replantacio-pomeres/ www.irta.cat**

Rationale

The renewal of fruit plantations increasingly requires replanting in plots previously occupied by fruit trees because it is difficult to find virgin fields and also because of the need to reuse hail nets and irrigation structures (they are still being amortised at the majority of modern plantations). In replant soil the trees experience growth difficulties in the first few years and the plantation's entry into production is significantly delayed. In extreme cases the plantations are not viable and have to be prematurely uprooted, resulting in economic losses. These effects are even more pronounced in weak vigour varieties of apple tree, such as the case of Jeromine(PBR), a Red Delicious clone extensively cultivated in Girona due to its acceptance in national and export markets. The causes are linked to soil exhaustion, whose origins and aetiology are complex and diverse.

There are numerous solutions to replant problems, ranging from the application of the biocides permitted by current regulations (although their use is limited) to the application of large quantities of nitrogen to stimulate the growth of the trees. This innovative pilot project proposed the assessment of a series of alternatives (rootstocks, biofumigants, mechanical methods, application of organic matter or slow-release fertiliser), in addition to better water management in the initial periods, which would lead to sustainable management without compromising productivity in apple trees in replant soil. This objective was broken down into the following actions:

1. Assessment of rootstocks that tolerate replant soil.
2. Biofumigation with mustards and grasses.
3. Mechanical methods for the modification or replacement of the planting bed.
4. Improvement of nitrification through the incorporation of organic matter and other techniques that increase the vigour of the trees.
5. Biological control agents and biostimulants.
6. Management of irrigation in the post-planting period.

The tests were undertaken both in commercial apple tree plantations and in experimental plots, all with replant soil.

The plots were in different locations in the fruit-growing areas of L'Alt Empordà and El Baix Empordà (Girona) and the specific tests were carried out at the Mas Badia Agricultural Experiment Station (AES) in La Tallada d'Empordà (Girona).

Results and conclusions

Under the experimental conditions of the studies carried out in this project, it can be concluded that:

1. The new rootstocks present good productivity, induce good calibre and are a little more vigorous than traditional M.9 selections like G.11 and G.41. This makes them more suitable for weaker varieties (such as Jeromine(PBR)) and for replant soil.
2. Biofumigation done with white mustard and fodder turnip contributes a significant increase in the vigour and height of trees with respect to control trees (with no strategy prior to planting).
3. The incorporation of manure (monoammonium phosphate) and organic amendments (leaf mould, composted cow manure) during planting shows a tendency to improve the growth of the trees with respect to the control trees (without any additions).
4. The application of mustard meal (Biofence) shows a significant improvement in the growth of the trees and also greater yields in the first harvest. It has also shown a higher content of nitric nitrogen in the soil.
5. The application of biological control agents (*Trichoderma harzianum* T22 (TH-Promotor) or *Bacillus subtilis* (Amylox-x)) or of root biostimulants (RootipStart) shows a tendency to maintain or improve the growth of trees with respect to the control or with respect to the standard strategy (with monoammonium phosphate and leafmould), but without significant differences.
6. The application of slow-release fertiliser (Agroblen) shows a tendency to maintain or improve the growth of the trees with respect to the standard strategy (with monoammonium phosphate and leafmould), but without significant differences.

The most significant results obtained so far give rise to the following recommendations for new plantations in replanting situation:

- Use more vigorous and more tolerant rootstocks than M9, types G11 and G41.
- Use biofumigation.
- Apply a substrate/organic amendment to the planting line.
- Apply mustard meal, while continuing to work on the most suitable application technique.

Figure 1. *Comparison of 'Jeromine(PBR)' espalier-trained trees with rootstocks G.11 and M.9 EMLA during the second crop of the season in replant soil shortly before the 2017 harvest at the Mas Badia Agricultural Experiment Station (AES). Source: Mas Badia Foundation.*

DEVELOPMENT OF A SLURRY CONCENTRATOR THAT CONTINUOUSLY COLLECTS DATA ON TOTAL NITROGEN, PHOSPHOROUS AND ORGANIC MATTER IN THE TWO PHASES OBTAINED.

Leader:	**Plana de Vic Agricultural Cooperative and Credit Section**
Coordinator:	**Catalan Federation of Agricultural Cooperatives (FCAC)**
Other members:	**Balmes University Foundation (University of Vic – Central University of Catalonia); Grup Solucions Manresa, SLUP**

Rationale

The main rationale of the Operational Group was to validate solutions to reduce slurry management costs by applying a new process in which slurry directly from the farm is separated into two phases: a semi-liquid phase (concentrating the majority of the organic matter and nutrients and the largest particles); and a liquid phase (with a low nutrient concentration). The differentiated management of the two phases is designed to minimise transport costs and optimise the application of nutrients to the soil from the agronomic and environmental perspectives.

The objectives of the project were:

– Implement the monitoring of the flow and of the concentration of nitrogen using equipment/sensors to determine at all times the efficiency of the treatment and the distribution of the nitrogen in both phases.

– Minimise the construction and operation costs (including energy consumption) of the new process/technology (concentrator).

– Ensure that the materials that form the concentrator are resistant to their intended environments and guarantee the durability of the equipment.

– Assess the implementation of the concentrator at existing facilities without substantially modifying the storage structures.

– Reduce the cost of transporting elements of agricultural value, such as nitrogen, phosphorous, potassium and organic matter.

– Determine the environmental impacts using life-cycle assessment (LCA) tools and the economic viability of the process using life-cycle costing (LCC) tools .

Results and conclusions

The concentrator designed and constructed in this project presents satisfactory results. The concentrator prototype created for slurry tanks obtained a semi-liquid phase with a high concentration of organic matter and nutrients and a liquid phase with a low concentration of nutrients.

The volumetric dilution rate from breeding farm slurry ranges from 73 to 88%. In fattening slurry, the dilution rate is lower (17%). Breeding farm slurry obtained an average concentration by volume of 18%, of which 32% was total nitrogen and 77% was total phosphorus. There was no concentration of potash. There was evidence of component stratification, such as the case of organic nitrogen and phosphorus, which were mainly in the concentrated phase due to their tendency to be retained in the sediments.

The conductivity measures showed good correlations for total and ammoniacal nitrogen and potash. Energy consumption and conductivity were continuously monitored with the established monitoring system. However, the system must be improved to minimise oscillations of conductivity data. The energy consumptions of the processes were low, achieving in the most unfavourable tests a level of 0.27 kWh m-3 (0.27 kWh·m-3 * €0.13 kWh-1 = €0.0351 m-3).

The joint analysis of the results of the pilot project provides evidence of the technological and economic viability of the new concentrator in accordance with the aims of the Operational Group.

Figure 1. *Floating structure with a guide that keeps the concentrator at the right height for operation in the tank. Source: Plana de Vic Agricultural Cooperative.*

Figure 2. *Side view of the concentrator: Source: Plana de Vic Agricultural Cooperative.*

IMPROVEMENT OF THE TECHNOLOGICAL QUALITY OF PORK FOR THE MANUFACTURE OF COOKED HAM THROUGH OPTIMAL GENETIC SELECTION

Leader:	**Selecció Batallé, SA**
Coordinator:	**Innovacc**
Other members receiving aid:	**Joaquim Albertí, SA**
Other members:	**Institute of Agrifood Research and Technology (IRTA)**

Rationale

Companies in the Catalan meat industry, especially those that produce cooked ham, have witnessed an increase in recent years in the incidence of meat of a quality unsuitable for acceptable products. Recent scientific studies indicate that to a great extent this is determined by the genes of the animals, given that they have tended to select animals that provide high meat yields and high levels of productive efficiency, but with more quality problems.

One of the main problems encountered by Catalan cooked ham producers is how difficult it is to obtain maximum quality fresh ham, making it necessary to carry out a raw material selection process upon reception of the material at the factory in order to discard any pieces considered to be defective in accordance with criteria not always based on objective quality parameters. This raw material selection process needs to be improved and the pieces need to be classified in accordance with objective parameters.

Once the ham has been prepared, it is necessary to assess whether any deficiencies observed in the raw material result in poor quality in the end product, including a greater loss during the process, less yield in slicing, areas with denatured fibres and colour tones that are unacceptable to the consumer.

The objective of this project was to obtain consumer meat from white pigs at affordable prices that is more attractive to the end consumer. The project sought to achieve a product based on high-quality raw materials that does not require any additives.

First, the aim was to improve the technological quality of the pork to be used for the cooked ham, specifically the colour, texture and water retention capacity of the pork. This would achieve a significant reduction in the cost of producing cooked ham. To achieve this objective, the most suitable types of pig for the production of pork for cooked ham were identified using innovative genetic improvement technologies and systems to measure the quality of the meat and the finished product. The aim was to obtain different types from four batches of white pigs through differentiated and predictably optimal genetic selections, where A was the control group to be compared with the improved groups B, E and F.

Second, the project studied the use of technology based on Near Infrared Spectroscopy (NIRS) to establish equations to predict the quality of the fresh meat and the finished product. The implementation of this technology aimed to provide an alternative to the reference methods applied to determine the quality of the meat and improve the control of the pieces of meat obtained from animals with different genes and the quality control of the raw material upon entry to the cooked ham plant.

Results and conclusions

With regard to the obtaining, raising and fattening of different types of pig, the results have shown that genetic selections F and B are valid ways to improve the quality of cooked ham.

With regard to predictions of quality parameters with NIRS, although the data show a certain level of differentiation in some of the characteristics of interest, precision was low. This could be due to major variability within a single category or range of the spectrum used by the team. It could be possible to improve the predictions by increasing the number of samples assessed with a suitable design.

Figure 1. *Batallé Piétrain terminal boar. Source: Batallé*

Fattening performance							
		A	B	E	F	*Signif*	RMSE
BATCH 1	ADG (g/day)	870_{b}	861_{b}	933_{a}	858_{b}	***	26.9
BATCH 2	ADG (g/day)	901_{c}	933_{bc}	1016_{a}	968_{b}	***	88.0
	Conversion Index feed kg/live weight kg	2.32	2.32	2.29	2.32	NS	0.05
	Performance carcass kg/live kg (%)	75.4_{a}	75.4_{a}	72.7_{b}	71.6_{c}	***	1.76
	Conversion Index feed kg/carcass kg	3.05_{ab}	3.03_{b}	3.15_{ab}	3.24_{a}	*	0.13

Table 1. *Fattening performance Source: Operational Group.*

NEW NATURAL STRATEGIES TO REDUCE POST-HARVEST DISEASES IN PIP FRUIT.

Leader:	**Societat Cooperativa Sant Domènec**
Coordinator:	**Altinco, SL**
Other members:	**Afrucat; Centre for Biotechnological and Agrofood Developments (DBA); Institute of Agrifood Research and Technology (IRTA)**

Rationale

One of the biggest problems in the fruit growing sector is the cold storage of pip fruit susceptible to superficial scalding , which deteriorates its appearance and reduces its market value. Until recently, scalding control was based on the use of chemical substances (such as ethoxyquin and diphenylamine) responsible for blocking the oxidation of compounds like α-pharnesene. Recently, the market has seen the introduction of natural products based on essential and vegetable oils that when applied before and during cold storage may be effective in the control of scalding.

The overall objective of the project was to assess different pre- and post-harvest farming conditions with the use of natural products to reduce the incidence of problems associated with cold storage, such as the superficial scalding of pip fruit. Accordingly, actions were undertaken to:

– Determine the effectiveness of the pre-harvest application of natural products to increase the absorption of macro and microelements in the fruit, and assess their impact on the quality parameters of the fruit and their predisposition to disease.

– Study the effectiveness of the post-harvest application of various natural treatments.

Results and conclusions

In the pre-harvest trial to assess the effectiveness of the natural product applied to the leaves (AL1510) to increase the absorption in the fruit of macro and microelements and their impact on the quality parameters, the following should be highlighted:

– In both Blanquilla pears and red apples, the application of the natural product produced a slight tendency to more firmness than in the control group.

– In both crops a tendency towards an increase in calcium was observed in the areas where the natural product was applied.

– In red apples, significant differences were not observed in the qualitative or mineralogical analyses, with the exception of boron.

Although a tendency to improve firmness and Ca and K levels in Blanquilla pears and in red apples was observed when AL1510 was applied, no significant differences with the control subjects were detected. A prolonged study is necessary to obtain conclusive results, given that there are many annual variables that can affect a tendency towards the appearance of scalding.

The test to assess the post-harvest application of natural products (oil of clove, lecithin and sucrose fatty acid esters) studied the evolution of the content of α-pharnesene, conjugated trienols and ethylene. The most significant results are as follows:

– Blanquilla pear: the values are similar for all the analysed parameters, but there is a tendency towards higher values with oil of clove.

– Red apple: the values are dispersed between treatments; oil of clove tends to give lower values.

Therefore, all three natural products are recommendable as a natural alternative to control scalding in the cold storage of the studied pip fruit.

Figure 1. *Experimental assembly used for the determination of ethylene. Source: Centre for Biotechnological and Agrofood Developments (DBA).*

Figure 2. *Red Delicious apple variety without scalding. Source: Societat Cooperativa Sant Domènec.*

Figure 3. *Red Delicious apple variety with scalding. Source: Societat Cooperativa Sant Domènec.*

Figure 4. *Blanquilla pear variety without scalding. Source: Societat Cooperativa Sant Domènec.*

Figure 5. *Blanquilla pear variety with scalding. Source: Societat Cooperativa Sant Domènec.*

ALTERNATIVE TO TRADITIONAL FUNGICIDE TREATMENTS APPLIED TO POST-HARVEST APPLES AND PEARS

Leader:	**Fructicultors de Girona Plant Defence Group (ADV)**
Coordinator:	**Fructicultors de Girona Plant Defence Group (ADV)**
Other members receiving aid:	**Fruita d'Alcarràs, SAT**
Other members:	**Mas Badia Foundation; Institute of Agrifood Research and Technology (IRTA)**

Rationale

Fruit growing in Catalonia represents 15.5% of agricultural production, with pears and apples being the main species. During its conservation in cold stores 4 to 6% of the fruit may suffer defects, of which 50% are caused by rotting. The method most used to control them is a post-harvest application of synthesised fungicides by means of a drencher. This drencher application increases the residue on the fruit, complicates the handling of fruit within the plant and creates a treatment water management problem.

The main objective of the project was to seek alternatives to post-harvest fungicide treatments to control rotting, focusing on:

1. Developing effective strategies based on field applications of chemical and/or biological products to control the main post-harvest apple and pear pathogens that generate the lowest possible levels of residue.

2. Developing cleaning and disinfection strategies for packaging, environments and surfaces in fruit and vegetable plants that reduce inoculum sources that cause post-harvest rotting and do not leave residue on the fruit.

3. Assessing the potential of various post-harvest strategies to eliminate or reduce pesticide residue on the fruit to be sold.

4. Establishing a handling strategy for each variety (or group of varieties) to control the pathogens that affect post-harvest apples and pears without the need for drencher application.

Results and conclusions

The incidence of post-harvest diseases after applying chemical or biological fungicides in the field varied according to variety and year. The strongest effect was observed in the Fuji apple variety, followed by Red Delicious Jeromine and Pink Lady and the Conference pear variety. The funguses responsible were also diverse: *Alternaria* in Red Delicious, *Gloesporium* and *Phytophtora* in Pink Lady, *Penicillium* and *Alternaria* in Conference, and *Monilia*, *Botritis* and *Penicillium* in Fuji.

It was observed that pre-harvest applications of the fungicides Boscalid+Pyraclostrobin, Fludioxonil and Fluopyram+Tebuconazole are equally effective as post-harvest treatments in apples and pears.

With regard to trials to study the effect of eliminating pre-harvest fungicide treatments, the results showed that in early apple varieties conserved for less than a week it is not necessary to apply fungicidal treatments, given that the difference between doing so and not doing so is negligible (provided that the cleaning and disinfection of the environment are correct).

The cleaning of the environment and of the packaging is essential, as it can significantly reduce the number of colonies. The most effective ones were Aero Green DT and Dioxpure, with reductions in the number of colonies in the environment of the cold store in excess of 90%. The reduction of the rest of the assessed disinfectants (Fruit Green DTC, Fruit Green DTM and Dybag NT 2g) was statistically lower than that of the previous ones, with values around 51%. With regard to packaging, it was observed that the effectiveness of disinfectants is higher on wood than on plastic and the pathogen that proved most difficult to control was *Rhizopus* spp. Finally, it should be noted that the two disinfectants whose effectiveness was not affected by either the pathogen or the surface to be assessed were Fruit Epro and Dybac NT 2G.

The removal of active matter residue has been found to be much more effective if done just after the harvest than after the storage period. Rinsing with just water or with the addition of disinfectants does not completely remove the residue from the fruit, but reduces the amount.

Figure 1. *Main post-harvest diseases that affect pip fruits (from left to right):* Penicillium expansum, Alternaria *sp. and* Gloesporium *sp. Source: IRTA Mas Badia.*

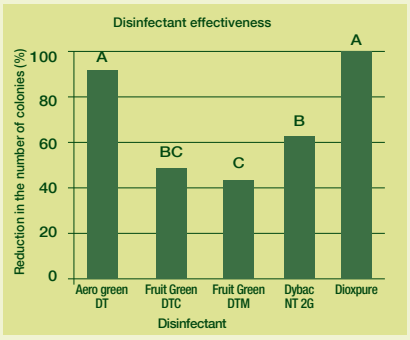

Figure 2. *Reduction of the number of colonies of* P. expansum *according to the disinfectant assessed. Source: IRTA Mas Badia.*

EXTENSION OF THE USEFUL LIFE IN COLD STORAGE OF VACUUM-PACKED PIECES OF BEEF TO 84 DAYS FOR EXPORTATION

Leader:	**Anafric**
Coordinator:	**Institute of Agrifood Research and Technology (IRTA)**
Other members receiving aid:	**Companyia General Càrnia, SA; Sala de Desfer i Magatzem Frigorífic J. Viñas, SA**
Web:	**http://www.irta.cat/ca/resultats-go-extensio-vida-util-carn http://www.grupvinas.com/content/news/Extensio_vida_util_carn_vaqui_NdP_CAT.pdf https://www.youtube.com/watch?v=h4uxwQB_xbs**

Rationale

The exportation of beef in cold storage conditions to distant markets is an activity that generates strong interest in order to access market volumes with better commercial margins that contribute to more internationalisation and better economic results for the companies in the sector. The buyers in some of the countries of greatest interest require a shelf life for chilled packaged meat of at least 84 days to be able to cover both the transport time and customs processes and still have days left to distribute it within the destination country.

The objective of this project was to extend the commercial shelf life in cold storage of vacuum packed pieces of beef for exportation to 84 days. To do so, the actual transport conditions of the goods were reproduced in a container installed at Vic (a refrigerated container, or reefer, provided by Martiko) in order to monitor parameters such as light and temperature.

Achievement of the objective is based on three major pillars:

– Food safety and hygiene from the live animal and its butchery through to distribution. Minimise the potential for cross contamination from the industrial environment to the meat surface (spoilage microorganisms and pathogens) and the growing potential of both types of microorganisms.

– Packaging (materials, systems). Protection against chemical and physical contamination and minimisation of microbial recontamination and microbial metabolism/growth during storage. Contribute to improving preservation during shelf life, minimising the penetration of oxygen into the package and maintaining the sensorial and microbiological quality of the product.

- Cold logistics (depending on the growth speed of the spoilage microorganisms and/or pathogens present in the meat, and of certain chemical spoilage reactions). Determine whether near-freezing storage temperatures can contribute to lengthening the shelf life of fresh meat.

Multiple visits were made throughout the project in order to determine the right practices (hygiene, processing, packaging, etc.) both at the slaughterhouse and in the cutting room. The aspects to be improved were modified and then 42 animals were slaughtered for the study. Of these animals, 6 pieces from different slaughterhouses were analysed: loin, knuckle and chuck (E1) and shoulder clod, topside and loin (E2). These cuts were analysed from the microbiological and sensorial perspective.

Figure 1. *Packaged meat corresponding to a replica of a sample. Top: knuckle and chuck (left) and left and right loin (right) of animal 507 of E1. Bottom: right and left shoulder clod (left) and loin and topside (right) of animal 465 of E2. Sample 4, zone C. Source: IRTA.*

Results and conclusions

The objective of this Operational Group was very satisfactorily achieved in each and every one of the cuts. Up to 85 days of storage, all the vacuum packed beef cuts presented average count values lower than those considered to be necessary to cause taste changes (10^7 ufc/cm^2 or g). This matches the positive results of the sensory assessment, which produced values below 3.

The results were not conclusive in terms of the effect of the use of bags with a different oxygen mix for the packaging of clod and loin.

The cut that presented the lowest microbiological count levels in the entire study was knuckle, which also presented the lowest pH values and the best odour acceptability score. It should be highlighted that in none of the samples analysed in this study was the presence of *E. coli* detected. This microorganism is used as an indicator of faecal contamination and failings in good hygiene practices. Therefore, the results confirm the good practices applied at the start of the project for the preparation of the studied cuts.

This makes it possible for this product to be transported to new markets (domestic or international) and therefore for there to be an increase in demand and consequently in production in the primary sector and throughout the entire processing chain.

The project has equipped the sector with the tools necessary to be competitive and a benchmark on the global scale to adapt to the new demands of the market to be able to compete on the highest level with other countries that export beef.

PROFITABILITY OF THE APPLICATION OF NEW TECHNOLOGIES TO ACHIEVE IRRIGATION WITH MAXIMUM WATER EFFICIENCY AT A PILOT VINEYARD WITH 100 HA OF ORGANIC AND CONVENTIONAL VINES

Leader:	**Codorniu, SA**
Coordinator:	**Institute of Agrifood Research and Technology (IRTA)**
Other members receiving aid:	**Raimat Irrigation Community**

Rationale

In viticulture for winemaking, it is necessary to strike a balance between production and quality to be competitive and achieve maximum profitability. One of the main conditioning factors of agricultural production in the Mediterranean is the water status of the crop and the forecasts indicate that irrigation will be a key factor as a consequence of climate change. Choosing the programming of additional irrigation at all times is crucial to obtain the desired quantity and end quality of the product. In the case of vines, it is desirable to maintain the water stress level of the crop throughout the year within certain limits to obtain a product within the desired parameters.

It may be easier to control the water status of the soil than that of the crop, but it does not produce the same results, as it adds an intermediate step. In recent years, a number of technologies have made significant progress and, on the experimental scale and in highly controlled conditions, may facilitate irrigation management in such a way that water efficiency levels that were previously unimaginable can be achieved. But in practice, it is still necessary to integrate the effects of many factors that interact in the response of the crop (spatial heterogeneity of the soil, climate, phenology, seasonal sensitivity to water stress, the cultivation of the crop, type of variety).

The aim of this project was to demonstrate that, even in practice, the use of technologies (remote sensing, irrigation and cultivation simulation, automated devices in the plot) can enable highly efficient and economically profitable water management at large commercial vineyards that meet the minimum homogeneity requirements of their irrigation sectors. This solution includes the following aspects and sub-objectives:

1. Management of the control of plant water stress for each irrigation sector in the context of a large vineyard.
2. Reduction of the application of phytosanitary products and fertilisers by producing wine organically, considering the effect of this new management of the crop on irrigation requirements.

To achieve these objectives, the latest technology and knowledge were used in the programming of irrigation, remote sensing and crop models. Improvements were also made to the engineering of the network by means of plot division protocols to obtain more homogeneous zones.

During the 2016 and 2017 irrigation seasons, differential irrigation management was applied to three varieties of vine (Cabernet Sauvignon, Tempranillo and Syrah) making use of physiological measures (leaf water potential and fraction of intercepted radiation), simulation models and remote sensing.

Results and conclusions

With precision irrigation, water savings of 25% were achieved in relation to previous years. Moreover, productive yield and the composition of the grapes were improved. The analysis of spatial variability within the vineyard (using plant vigour indexes obtained from multispectral satellite images) showed a 10% reduction in interplot variability within the same irrigation sector.

This technology will benefit the winemakers by increasing water use efficiency and improving grape yield and composition.

It should be noted that it was necessary to carry out a large number of physiological measurements to programme the irrigation, which significantly increased the cost of production, and, for the moment, makes implementation of this method on the commercial scale inviable. Work should be continued on the development of tools capable of estimating the water needs of the crops through the integration of modelling and remote sensing, and avoiding, as far as possible, taking field measurements in order to reduce costs.

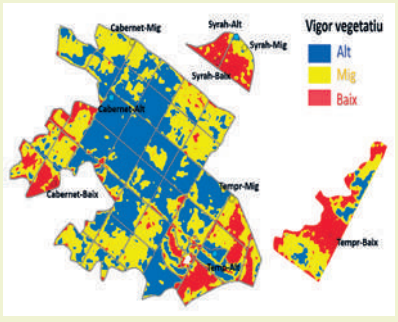

Figure 1. *Map of the plant vigour of a vine with the Tempranillo, Cabernet Sauvignon and Syrah varieties, obtained with multispectral airborne images showing vine classification in accordance with the level of plant vigour. Source: Codorniu – Agropixel.*

Figure 2. *Ceptometer, a device to measure the intercepted radiation fraction of the vine. Source: IRTA Efficient Use of Water Programme.*

Figure 3. *IRTA technician measuring the water status of the vine with a Scholander pressure bomb. Source: IRTA Efficient Use of Water Programme.*

WATER SAVING IN THE CULTIVATION OF RICE THROUGH THE INTRODUCTION OF INNOVATIVE AGRONOMIC TECHNIQUES

Leader:	**El Molí de Pals Irrigation Community**
Coordinator:	**Mas Badia Foundation**
Other members receiving aid:	**Irrigation Community of the Ebro Delta Right Bank Canal**
Other members:	**Arròs de Pals Plant Defence Group (ADV); Arròs Estany de Pals, SCP; El Restallador, SL; Farratges Baix Ter, SL; IRTA Ebre Irrigation Engineering and Management Group (University of Girona);**
Web:	**http://www.irta.cat/ca/projecte/grup-operatiu-estalvi-daigua-en-el-conreu-de-larros-mitjancant-la-introduccio-de-tecniques-agronomiques-innovadores/**

Rationale

Water saving in Mediterranean Europe is increasingly essential because water is becoming a scarce resource, in terms of both quantity and quality. This will very probably be a key aspect in the coming years in the agricultural sphere. The low efficiency in the use of irrigation water associated with the cultivation of rice is a major handicap within the framework of the water management of the irrigation communities. Although the anoxic cultivation of rice may be associated with the need to rinse salts from the soil, on other occasions it responds solely to the traditional methods employed in Catalonia.

The main objective of the project was the introduction of agronomic techniques and innovative processes that save water in rice growing. To achieve this general aim, the following specific objectives were developed to quantify the consumption of water and determine the changes to be made in terms of seed doses, weed control, pre-seeding fertilisation, and the impact on certain infestations (chironomids, apple snails, red swamp crayfish):

1. Determine the advantages and disadvantages of dry sowing in the cultivation of rice.

2. Determine the advantages and disadvantages of drip irrigation in the cultivation of rice.

3. Determine the advantages and disadvantages of intermittent irrigation to complement dry sowing.

Dry sowing was studied in the Ebro delta, and also in the province of Girona along with drip systems and intermittent flooding irrigation.

The volume of irrigation water applied was measured and the water content in the soil was continuously monitored.

Results and conclusions

Dry sowing enabled water savings of 8 to 10% with respect to the traditional method, given that flooding is applied 3 to 6 weeks later. It also enabled a 30% saving in seeds and reduced pest populations (slowing down the proliferation of apple snail for example) and ducks. The limiting factor is salinity, given that in rice areas the concentration of salt in a plot may be increased by the flooding of neighbouring plots, making dry sowing impossible. Moreover, during sowing, the land cannot be too wet or too dry for the proper germination of the seeds and therefore the implementation of dry sowing depends on the amount of rainfall in the weeks earmarked for sowing. If the land is too dry, it could be moistened before or just after sowing. Rainfall can make it difficult to work the land to facilitate sowing with a line seeder. When it is not possible, there is the option of scattering the seeds with the soil flooded.

Figure 1. *Comparative view of a plot in the study: on the left, conventional sowing, and on the right, dry sowing a few days after flooding. Source: IRTA.*

The results confirm that water consumption in drip systems may be at least half of that in traditional flooding irrigation. But the cultivation of rice with drip systems causes problems in the agronomic management of the crop. The main disadvantage is that the irrigation system precludes the use of heavy machinery, which makes the application of certain fungicides/herbicides difficult or even impossible. Moreover, there are no herbicides for the cultivation of rice that are effective in non-flooded soil. Another problem that arises in drip systems is the difficulty in applying treatments against *Pyricularia* if varieties sensitive to this fungus are grown. The easy fertigation offered is one of the clearest advantages of this irrigation system.

Intermittent irrigation requires intensive monitoring to determine the start and end times of the irrigation. At the same time, it requires fields that are very level to allow the water to flow quickly. It is evident that it is necessary for the soil blocks at the edges of the field to be free of holes so there is no unusual loss of water.

REDUCTION OF THE MYCOTOXIN CONTENT IN CORN IN CATALONIA

Leader:	**Esporc, SA**
Coordinator:	**Esporc, SA**
Other members receiving aid:	**Agrària de Miralcamp, SCCL; Serveis Agrícoles Marull, SL**
Other members:	**Mas Badia Foundation; Institute of Agrifood Research and Technology (IRTA)**
Website:	**http://www.esporc.com/projecte-micocat**

Rationale

Corn is one of the most irrigated crops in Catalonia. The majority of its production is for the production of feed, mainly for pigs. The presence of mycotoxins in corn produces health disorders and conditions the performance of farms. Accordingly, in recent years buyers have increasingly demanded low mycotoxin content.

The main mycotoxins present in corn for grain are fumonisins, trichothecenes (DON) and zearalenones (ZEN). In recent seasons, more or less serious contaminations have been observed, making it advisable to implement good agricultural practices to limit their presence.

The general objective of the project was to reduce the content of mycotoxins produced in the field by funguses of the genus *Fusarium* in field corn in Catalonia.

The specific objectives were:

– Assess the susceptibility of commercial hybrids.

– Determine the effect of cultivation practices.

– Implement early and/or quick contamination warning systems to be able to apply preventive measures.

Results and conclusions

The most significant mycotoxins found in corn during the 2016 and 2017 seasons were: fusaric acid, fumonisins, trichothecenes (DON) and zearalenones.

Tolerance to fumonisins differs according to variety; transgenic varieties are the least risky.

Cultivation practices like rotation, non-delayed sowing and harvesting dates, and the minimisation of water stresses contribute to reducing the risk of contamination.

The early determination of mycotoxigenic funguses and mycotoxins and the application of a risk assessment model in accordance with agronomic factors improve the efficiency and productivity of farms and the nutritional quality and safety of feed for animal production. Having information before the harvest facilitates the application of preventive measures and the management of harvests to minimise contaminations. The difficulty is that currently there is no consensus on a threshold limit from which the predictive capacity of the harvest management model is considered satisfactory. In the final analysis, it is a decision to be taken by the producers, who must assess the consequences of assuming the risk of a mistake when assigning a specific commercial use to the harvests with a certain likelihood of exceeding the pre-established maximums (e.g. 12 to 25% observed in this project).

Figure 1. *Presence of* Fusarium *in corncobs. Variety sensitivity testing. Micocat Project, El Poal (Lleida) 2016. Photograph: E. Arqué, IRTA Lleida.*

Figure 2. *Sowing dates trial. Micocat Project, El Poal (Lleida) 2016. Photograph: A. López, IRTA Lleida.*

PIG FATTENING OPTIMISATION: FEEDING AND PRODUCT QUALITY

Leader:	**Grup Gepork, SA**
Coordinator:	**Institute of Agrifood Research and Technology (IRTA)**
Other members receiving aid:	**Baró Germans, SA; Selecció Batallé, SA; UPB Genetic World, SL**
Website:	**http://www.acbps.org/quisom/activitats/**

Rationale

The characteristics of fattening pigs produced in Catalonia evolve in accordance with the demands of the market, economic conditioning factors and the improvement programmes implemented at pig selection companies. Accordingly, it is essential to periodically characterise their genetic potential in order to determine the nutritional requirements and calculate optimal feeding standards in accordance with economic, quality and environmental criteria. In this sense, the four Catalan pig selection companies that make up this Operational Group proposed this project with the aim of:

– Developing new growth, protein deposition and consumption models for the hybrids currently bred in Catalonia. This information will be essential to be able to apply feed adapted to the potential of the pig type.

– Studying the yield in the final phase of fattening to determine the optimal slaughter weight of each genetic type analysed.

– Studying the quality of the meat of the current hybrids aimed at the production of carcasses with a high percentage of lean meat.

– Assessing diets and hybrids through new genetic alternatives as options for the production of differentiated pork.

The execution of the project focussed on the breeding, fattening and slaughterhouse control of six batches of piglets: four of the "lean" type from a Piétrain or similar father and two with "alternative" genes for the production of carcasses with high quality meat.

During fattening, the weight and fatness of the belly and loin were controlled every three weeks. Based on these data, measured using the Piglog 105 device, the percentage of body protein can be calculated. The control of feed consumption was continuously registered with an automatic consumption control station.

At the slaughterhouse, carcass and meat quality characteristics were controlled: thickness of the fat and loin (measured with the Fat-o-meater device), pH 24 h, electrical conductivity. The meat of the "alternative" genes animals was assessed more completely: percentage of intramuscular fat, fatty acids profile, etc.

Figure 1. *pH and temperature measurement of pig carcasses. Source: IRTA.*

Results and conclusions

The results of the fattening show clear differences by sex within each hybrid and also between the various types of pigs, and highlight the different productive potential between the lines and sexes of the pigs produced in Catalonia. The production of animals for specific markets, where quality variables are prioritised, is possible but generates an overcost that has to be passed on to other links in the meat supply chain.

The yields in the final fattening phase, between 105 and 117 kg, were specifically studied. In the majority of economic scenarios or production factor price combinations it is profitable to fatten the pigs to 117 kg.

It was possible to calculate the growth, protein growth and consumption models in the fattening in both types of pig. The results showed that thee progression of daily protein growth halts before growth stops (a difference of 10 to 15 days). The daily consumption of feed increases until the end of the fattening. The combined effect of the various trends in the evolution of growth and consumption is the progressive worsening of the transformation of feed into meat and the reduction of the protein content requirements in the feed at the end of fattening.

The phenotypes of the assessed animals (genes, sex, nutrition) show two clearly differentiated groups of animals/products. In the lean group, the lean percentage of the carcass is fostered, whereas in the quality group more emphasis is placed on the technological quality of the meat (pH, electrical conductivity...) and its composition (percentage of intramuscular fat).

REDUCTION OF THE SALMONELLA CONTAMINATION RATE IN PIGS

Leader:	**Granja Claret, SL**
Coordinator:	**Granja Claret, SL**
Other members:	**Agropecuaria Catalana, SCCL (Agrocat); Girona Swine Sanitation Group (GSP); University of Girona (UDG)**

Rationale

It is predicted that in the next few years the prevalence of salmonella at livestock farms will be a key aspect in the sale of animals to slaughterhouses or even a limiting factor in the sale of live animals and pork meat.

The purpose of this Operational Group was to establish a protocol to control and reduce salmonella contamination rates in all phases of pork production (breeding sows, transition and fattening) through the use of electrolysed water as a hygiene agent, a disinfectant and as drinking water.

The specific objectives of the pilot project were:

– Determine the initial bacteriological prevalence of salmonella infections at the pig farms included in the project.

– Identify the risk factors.

– Introduce electrolysed water as a sanitizer, a disinfectant and drinking water.

– Assess its effectiveness in the control of salmonella.

This experimentation was undertaken at three pig farms (breeding, transition and fattening).

Results and conclusions

At the breeding farm a slight reduction in the presence of salmonella (-2% prevalence in blood and -10% prevalence in faeces) was observed.

In the transition phase, the results obtained indicate that salmonella does not seem to be a problem (it was not detected). However, a slight improvement in the production parameters (reduction of losses and increase in live weight) has been detected in animals treated with electrolysed water.

At the fattening farm, a significant reduction in the prevalence of salmonella was obtained after the administration of electrolysed water throughout the entire period. At 80 kg, the prevalence reduction was 26% in blood and 34% in faeces.

The feed analysed during the project was not a salmonella risk factor. All the feed samples analysed were negative and the maintenance of the silos was found to be correct.

With all these results, it can be concluded that electrolysed water presents a significant sanitizing effect in all phases of pork production for the control of salmonella. Moreover, it is a good alternative for making drinking water on pig forms, given that it guarantees good microbiological quality.

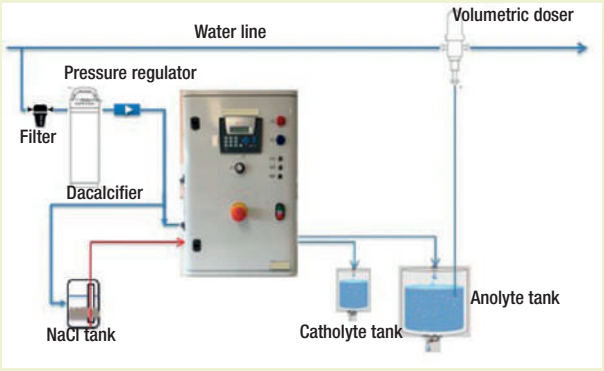

Figure 1. *Basic assembly of an electrolysed water unit. Photograph: Xavier Puigvert.*

Figure 2. *Installation of the electrolysed water unit at the fattening farm. Photograph: Xavier Puigvert.*

PET TREAT PRODUCTION PILOT TEST TO ADD VALUE TO SLAUGHTERHOUSE BY-PRODUCTS

Leader:	**Mafrica, SA**
Coordinator:	**Institute of Agrifood Research and Technology (IRTA)**
Other members receiving aid:	**Padesa**
Web:	**http://www.padesa.es/snacks-per-a-animals/** **https://www.youtube.com/watch?v=3zW2RpL60FU**

Rationale

This Operational Group's rationale was to seek a solution to add value to slaughterhouse products. The most usual way of using slaughterhouse products is the production of meal for animal feed. This project assessed as a business opportunity the conversion of pig, cow and sheep by-products into pet treats (animal products presented in formats that make them suitable for rewards, functional toys or snacks for pets). People who buy pet treats are usually very interested in the well-being of their pets, which means they will pay higher prices for these products than for normal pet food.

Pet treats are usually self-stable products, which are preserved without the need for cold, obtained from connective, muscular or bone tissue or organs that have normally been subjected to a thermal and/or dehydration process to ensure the destruction of pathogens and their microbiological stability.

The objectives of the project were:

– Use slaughterhouse by-products and energy recycled from the main activity to produce pet treats in an energy efficient manner.

– Diversify markets with complementary activities that generate value and profits and do not compete with the main economic activity.

– Optimise product concepts that already have a sales volume and create new concepts that enable a period of exclusivity and a higher profit margin:

· Adapted to the pet product distribution structures;

· Wide range of products from animals (poultry, pigs, cows, sheep);

· Recognised by the animals as a desirable treat and by their owners as healthy and safe.

Results and conclusions

A pilot project to create pet treats based on poultry and sheep slaughterhouse products has been successfully developed. The results of heat treatments applied to organs and/or soft tissue are very good. Heat treatments applied to bones, however, are too aggressive. In this case, the best option is a brine bath. However, not all whole pieces are suitable for pet treats (such as chicken feet).

The new pork products, moreover, reuse part of the residual energy from the slaughterhouse, mainly from the cooling systems. The tests showed that up to 42% of the residual energy can be reused.

In total, eight new pork products and five new poultry products have been obtained based on the creation of new formulations, the control of processes and the validation of food safety. The new pet food is cooked, cured and fermented. Moreover, other benefits, such as Omega 3, can be added, depending on the ingredients used. Innovative formats such as freeze-drying have been investigated in this sector. Freeze-drying offers a unique and highly innovative format, but its profitability must be studied. In addition to new formats, the nutritional quality of the snacks and their acceptance (using animals from municipal pounds and veterinary centres) were taken into account. All products processed in the pilot test are microbiologically safe.

Figure 1. *Meat biscuit snacks. Source: IRTA.*

Figure 3. *Meat sausage snack. Source: IRTA.*

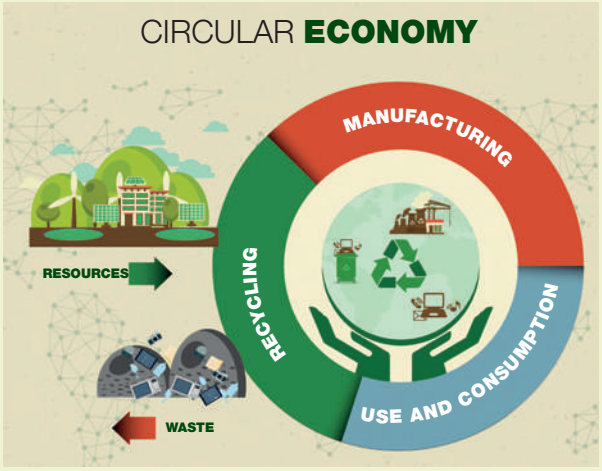

Figure 3. *Circular economy diagram. Source: all-free-download.com.*

IMPROVEMENT OF THE PRODUCTIVITY AND SUSTAINABILITY OF BLACK TRUFFLE PLANTATIONS THROUGH THE MICROBIOLOGICAL FARMING OF THE RHIZOSPHERE

Leader:	**Micologia Forestal Aplicada**
Coordinator:	**Micologia Forestal Aplicada**
Other members:	**Bioera, SL; Santiago Rosàs; Tofonejant, SL; Institute of Agrifood Research and Technology (IRTA)**

Rationale

Black truffle production is growing in Catalonia and it is possibly one of the crops with greatest economic potential, especially in agriculturally disadvantaged areas. Black truffles are often cultivated in areas with poor soil and low yields, where the trees present nutritional deficiencies and serious phytosanitary problems. One of the main problems in truffle farming is the irregularity of the harvest, which is possibly linked to suboptimal production conditions in both the nursery and the field. In contrast to the cultivation of trees for biomass or for their fruit, this is a case of a highly complex interaction between the tree and the rhizosphere (the interface area between the root of the plant and the soil). Moreover, the increase in single-species plantations (generally holm oak trees) may cause an increase in certain diseases and infestations that may reduce the production of truffles. Integrated farming of the rhizosphere may contribute to a general improvement in the vigour of the plants and their tolerance to biotic factors without the need to apply phytosanitary products.

The general objective of the project was to increase the production of black truffles in plantations established in Catalonia through the application of selected rhizobacteria strains and organic substances that act as activators of the germination of truffle spores and/or stimulators of the development of mycelium. To assess the capacity of different organic and rhizobacterial substances (and of their various combinations) to improve the biotic and abiotic conditions of the rhizosphere, the presence and availability of nutrients, the development of the plant phase of the truffle mycelium, the vigour of the tree (nutritional status) and pathogen control were taken into account.

The work of this Operational Group was carried out in three different experimental conditions: in mycorrhized plants in the nursery and in two holm oak plantations mycorrhized with black truffle, one in the production start phase with plants ranging from 2 to 7 years old and the other in black truffle production with plants older than 12.

Results and conclusions

The application of different rhizobacteria treatments, organic compounds and their various combinations did not present effects on the concentration of *Tuber melanosporum* mycelium in the substrate of the plants produced in the nursery.

In the case of the plot entering the production phase, the incorporation of rhizobacteria like *Bacillus liqueniformis* or *Pseudomonas fluorescens* and also the incorporation of organic compounds from different sources did have a stimulating effect on the development of *Tuber melanosporum* mycelium.

In the established plot that was already producing truffles, the incorporation of treatments based on rhizobacteria and organic compounds does not present a stimulating effect on the development of the mycelium of the fungus, given that the fungal composition of the rhizosphere is stable enough to be able to significantly modify the established balance with contribution likes those proposed.

In conclusion, the application of these products in young plantations in the establishment phase is advisable, and it is not necessary in the production phase of mycorrhized plants in the nursery or in adult plantations in the production phase. In view of the results obtained, it can also be concluded that the combinations of rhizobacteria and organic compounds did not present the expected overall effect. Further studies are necessary to design these possible combinations based on more data. With regard to the capture and accumulation of nutrients in plants, in all cases the detected effects were not very consistent and did not enable the detection of a treatment efficient enough to improve the nutrient content of the plants. There is not enough data to draw any solid conclusions.

Figure 1. *Mycorrhized plant nursery with Micofora truffles at IRTA Torre Marimon. Source: Micologia Forestal Aplicada.*

Figure 2. *Four-year-old plantation with sensors, Batea. Source: Micologia Forestal Aplicada.*

Figure 3. *Experimental adult truffle plantation in Granollers. Source: Micologia Forestal Aplicada.*

PIG VACCINATION TO REDUCE THE PREVALENCE OF SALMONELLA

Leader:	**Noel Alimentària, SAU**
Coordinator:	**Innovacc**
Other members receiving aid:	**Piensos del Segre, SA**
Other members:	**IRTA-CRESA**

Rationale

Salmonella contamination of pork poses a real threat to the Spanish and Catalan pork industries. The majority of studies reflect high prevalence of *Salmonella* spp. at livestock farms and slaughterhouses and in later stages of the pork product and pig derivative sale process.

In Catalonia, INNOVACC has coordinated a work group (with the collaboration of the DARP, ACSA, FECIC, PORCAT, ASFAC, and many other companies and institutions in the sector) to implement a voluntary plan to control pork salmonellosis, which since 2016 has offered the corresponding certification (PSP) to which farms and slaughterhouses can opt in to. In 2013, 2014 and 2015, a pilot study was carried out to determine the condition of farms and slaughterhouses in relation to salmonella contamination and to define, among all the participants, the minimum requirements to be met within this voluntary programme in terms of continued prevalence and the level of good practices at facilities.

This project represents another step forward in the work done so far. The preceding projects determined the infection situation and the aim now is to assess the effect of applying measures to combat and control it. Specifically, to assess whether vaccination in conjunction with the application of control measures at pig farms can help significantly reduce the prevalence of *Salmonella typhimurium* in carcasses at slaughterhouses.

S. typhimurium is one of the salmonella serotypes most commonly found at pig farms in Spain and also in cases of salmonella contamination at slaughterhouses and in the pork industry. It is also the serotype most commonly isolated in salmonella food poisoning cases.

The aim was for this pilot project to be reproduced in other companies in the Catalan pork industry.

Results and conclusions

The plan was to use a vaccine to reduce the prevalence of *Salmonella typhimurium* at farms with endemic infection, where the usual measures (control, biosafety, increased hygiene, strict handling and the use of additives) have not been sufficient.

The vaccine could not be applied because the salmonella strain that theoretically was the most abundant in Catalonia (*S. typhimurium*) was not found in sufficient amounts at the farms at which environmental and faeces samples were taken. Moreover, the only farm where the vaccine could have been tested (although it had a very low prevalence of *S. typhimurium*) experienced episodes of PRRS, and this was one of the contraindications of the vaccine. Economic viability also had an effect due to the scarce presence of *S. typhimurium* detected at the farms where the test was to be performed and due to the high cost of the vaccine (given that all the sows and piglets would have to be vaccinated). So many factors against it made the application of the vaccine inviable.

Figure 1. *Sow with sucklings. Source: Eudald Casas (INNOVACC).*

Figure 2. *Weaned piglets. Source: Eudald Casas (INNOVACC).*

Photo 3. *View of the pig pens. Source: Eudald Casas (INNOVACC).*

Photo 4. *View of the farm. Source: Eudald Casas (INNOVACC).*

IMPLEMENTATION OF AN ORGANIC PLOT OF TRADITIONAL AND RESISTANT APPLE TREE VARIETIES, AND THE RESOLUTION OF WEED AND RODENT PROBLEMS

Leader:	**Serrater, SL**
Coordinator:	**Serrater, SL**
Other members:	**Casadellà Explotacions Agrícoles, SL; Mas Badia Foundation**

Rationale

The demand for organic products is growing. However, organic fruit growing is still being developed, given that its production process is more difficult. Consequently, organic production is an option for the modernisation of fruit farms, the diversification of growers' production and the achievement of greater value from the agricultural products obtained. Organic apple production is a reality in other European countries and it could be here too. Traditional varieties and new resistant varieties with high organoleptic quality, in conjunction with modern production techniques, offer advantageous options for the cultivation of organic apples.

The main objective of the Operational Group was to solve the two main problems of organic farming identified in the Girona fruit growing area: weeds (particularly in the case of young trees) and rodents (the European water vole). This should enable the consolidation of the organic production of traditional and resistant varieties of apples.

A new plot of organic apple trees was planted with conventional and resistant varieties with the corresponding infrastructure (structure for hail nets, drip irrigation, perimeter fencing to keep water voles out, etc.). Specific actions were also taken to solve the problems identified in previous projects: weed and rodent control.

Results and conclusions

The project was carried out without any problems. The varieties were assessed in accordance with their characteristics and suitability for organic farming. The most significant difficulties were insufficient growth of the trees in 2016 due to phytotoxicity (excessive concentration of salts around the roots) and a significant colonisation of voles on the plantation in 2017, despite the passive protection systems that were in place.

The resistant varieties did not show any symptoms of apple scab disease. In the Golden Orange and Golden Reinders varieties *Alternaria* damage was found and Crimson Crisp was highly sensitive to powdery mildew. Colonies of Ceroplastes scale insects were found in most of the varieties. Other parasites common to apple tree plantations were found in low or very low numbers and were satisfactorily controlled.

Vole control using agronomic measures, passive preventive methods (nets) and the use of mechanical traps was wholly insufficient.

Additionally, a tractor-drawn device has been designed to solve the problem of weeds in the tree line, although it needs to be more precisely adjusted to prevent damage to young trees with a fragile root system.

The cultivation of host plants in between the rows is an advisable practice because it propitiates the introduction and establishment in the territory of numerous species of beneficial organisms.

Figure 1. *Appearance of the Bio 16 organic plantation shortly after being introduced (March) and in late September 2016. Source: IRTA Mas Badia.*

Figure 2. *Appearance of the Bio 16 plantation in spring, and in autumn prior to harvesting the Gala Schnico variety in 2017. Source: IRTA Mas Badia.*

BIOLOGICAL CONTROL OF INFESTATIONS AT COMMERCIAL APPLE PLANTATIONS

Leader:	**Giropoma Costa Brava, SL**
Coordinator:	**Giropoma Costa Brava, SL**
Other members:	**Mas Badia Foundation; Pareta Rubau, SL; Ultpoma, SL**

Rationale

The objective of the project is to foster the use of alternatives to phytosanitary products; reduce phytosanitary products and problems arising from the presence of residue on fruit; restore, conserve and improve biodiversity; modernise fruit farms by prioritising defence methods with a low environmental impact and, finally, foster cooperation for innovation between the production sector and research.

Plant protection is one of the main pillars of the production process to achieve quality production with maximum commercial value. The Fruit.Net Programme, which has been developed throughout Catalonia since 2011 and in which all the organisations in the Girona fruit sector participate, has prioritised the use of defence methods as alternatives to phytosanitary treatments and, therefore, reduced the number of chemical applications in comparison with conventional plantations. However, the production process continues to depend excessively on the application of chemical products.

Major food distribution chains are increasingly demanding reductions in the use of plant protection products in order to be able to market fruit that is completely free of residue and avoid potential health problems. This makes it necessary to take advantage of biological pest control systems and other non-chemical systems at fruit farms.

The project revolves around the reduction of the use of phytosanitary products for pest control at commercial plantations of apple trees fully protected with polyethylene nets, through the use of biological control. The target pests are the rosy apple aphid (*Dysaphis plantaginea*), the wooly apple aphid (*Eriosoma lanigerum*) and the obscure mealybug (*Pseudococcus viburni*). The protection against the rest of the common pests (codling moth (*C. pomonella*), oriental fruit moth (*Cydia molesta*) and Mediterranean fruit fly (*Ceratitis capitata Wied.*)) was done passively with insect nets or biotechnical methods.

Results and conclusions

The application of a defence strategy over two years at commercial plantations of apple trees fully protected with polyethylene nets based on the biological control of aphids and *P. viburni* made it possible to conclude that:

1. The exclusive release of beneficial organisms was not sufficient to achieve the absolute biological control of potentially more harmful species of aphids (*Dysaphis plantaginea* and *Eriosoma lanigerum*).
2. The use of agronomic practices such as autumn treatments with kaolin in conjunction with closing the plantations off with polyethylene nets until mid-December did not fully prevent the immigration of the rosy apple aphid infestation on the plantation and the formation of colonies in the shoots of apple trees in the following spring.
3. In the plantation of tress with controlled vigour, the joint use of the release of beneficial organisms (parasitoids) with agronomic practices to prevent the immigration of rosy apple aphids to the plantation and a pre-floral insecticide treatment made it unnecessary to apply other insecticides to control aphids and other infestations throughout the season.
4. At plantations fully covered with polyethylene nets, infestations of moths (codling moths, oriental fruit moths) and fruit flies were satisfactorily controlled. In some cases, however, even though the plantations were closed off, it was necessary to use non-chemical methods and biological support products.
5. The biological products tested for the control of *P. viburni* were not effective in the control of this insect and no differences were found between them. The chemical strategy was found to be more effective.
6. At plantations covered with nets and with support methods other than chemical methods, the number of conventional insecticide applications can be significantly reduced. For the first time, a commercial plantation of apple trees has obtained a normal production level without any losses using a single insecticide treatment throughout the year.

Figure 1. *Insect hotel to shelter beneficial organisms installed at the farms taking part in the project (left) and completely covered plot (right). Photograph: Marià Vilajeliu, IRTA-Mas Badia.*

INTERVIEWS WITH MEMBERS OF THE OPERATIONAL GROUPS FROM THE 2015 CALL

Today, innovation and research are the key to business competitiveness, and collaboration between producers, research centres and organisations is fundamental for excellence in their development and application. In this area, the Operational Groups, fostered by the European Union, are the ideal framework to strengthen synergies and complementarities between the various actors.

In this article our aim is to reflect the experience of the members of the Operational Groups through a number of examples:

Ricard Carreras, head of the Mafrica R&D&I Department, leader of the Operational Group "Pet treat production pilot test to add value to slaughterhouse by-products" (see page 25).

Joan Serra, researcher at the Mas Badia Institute of Agrifood Research and Technology (IRTA), the research centre of the Operational Group "Reduction of the mycotoxin content in corn in Catalonia" (see page 22).

Marius Simon, technician of the Grants and Projects Area of the Catalan Federation of Farming Cooperatives (FCAC), coordinator of the Operational Group "Development of a slurry concentrator that continuously collects data on total nitrogen, phosphorous and organic matter in the two phases obtained" (see page 15).

QUESTIONNAIRE

Are you satisfied with the achievement of the project objectives?

Ricard Carreras: Yes, we are very satisfied. We produced pilot quantities to be able to determine the most suitable processes for each of the by-products we decided to include. We also conducted taste tests with pets and studied how the market would respond.

Joan Serra: Yes, I am very satisfied. I think we are going to achieve the main objective of helping producers minimise the risk of mycotoxin contamination in corn for feed production, and we also contributed to improving the competitiveness of local production with respect to imports.

Màrius Simon: Yes, we met all our objectives. It was a pilot project without any significant difficulties and everything was satisfactory. I think that it has a lot to do with being a highly specific project and the fact that the members have previously developed other innovation projects.

Are the results of the project in line with your initial expectations?

Ricard Carreras: Yes, we managed to recover slaughterhouse by-products and reuse energy from the main activity. From the range of initial possibilities we chose some, discarded others and adopted new ones as they arose. Finally, we centred on pork products that we can prepare and sell directly, with a basic drying process that enables us to obtain a natural 100% meat product with a shelf life of more than a year without cold storage.

With regard to energy, we managed to reuse part of the glycol used for cooling to dry the by-products.

Joan Serra: Yes, moreover, I think that there was a before and after in terms of knowledge.

For example, before we started we were not sure which varieties were most tolerant to mycotoxins. Now we know them, and just by preventing their cultivation we have made a leap forward in terms of the quality of the resulting product. We initially only considered the three most significant mycotoxins, but as the project progressed we were able to assess many more, and now we have a more specific map of the situation in most of Catalonia. This allowed us to make roadmaps for the producers that, without fully eradicating the problem, considerably reduce it. There has also been a before and after for seed companies, which have become more aware of the problems, and for buyers, who have participated in the producers' problems.

Màrius Simon: Yes, absolutely. It could have turned out like many other innovation projects, concluding that the developed processes or products do not have any practical application or cannot be marketed… Sometimes it is worth proving that something is not possible to prevent more resources being needlessly assigned to a new business line or improvement, but this was not our case. In fact, it has resulted in a business initiative associated with the Plana de Vic cooperative, which led the project.

How has the project contributed to the innovation culture of your company/organisation?

Ricard Carreras: Mafrica has its own R&D&I department. This type of help is good for us, because although we would develop this activity anyway a subsidy to collaborate with research centres allows us to cover our expenses and take bigger risks.

Joan Serra: Projects like this allow research and innovation professionals to more clearly see the possibilities and results of collaboration between the public and private sectors. The results of the research can be applied to more palpable actions when you work with the industry and the producer. They lead the project so they can use it.

Màrius Simon: When we take part in projects as a coordinator, we monitor the financial, technical and administrative aspects and also act as a bridge with the Ministry of Agriculture, Livestock, Fisheries and Food (DARP). Each of these experiences enriches the federation. In our case, and with regard to the Operational Groups, it also has the added value of working more closely with federated cooperatives and obtaining more satisfactory results.

Will what you have achieved with this project open the door to future initiatives?

Ricard Carreras: Yes, even though the grant has ended, the project will continue and it has paved the way for us to continue improving. Our aim is to incorporate new products when we find a solution to the problems of discarded by-products. We also have a lot of work to do in the matter of packaging.

Joan Serra: Definitely. We have taken a step forward in research and this always leads to new challenges. We have seen the importance of plant material and this will force us to update the information with any new varieties that may arise.

It has also allowed us to come into contact with other types of production, such as fodder products, and it has shown us that there is still a lot more that can be done with corn.

Màrius Simon: Yes, the experience we have garnered and the contacts we have made with the members of the group will open the door to future collaborations. Additionally, for the FCAC, the Operational Groups represent an opportunity with great potential in the field of innovation consultation and transferring this innovation to the cooperatives and to the sector. We are very interested in explaining these experiences to cooperatives that have not been involved much or at all in R&D&I projects and helping them on the path they need to take if they are to improve their competitiveness.

How do you rate the general work dynamic of Operational Groups? Have you encountered any difficulties?

Ricard Carreras: Our collaboration with other subcontracted companies, the IRTA and Padesa was very smooth. Although we did not end up developing a joint and broader line of products with the other partner, everyone's level of involvement was very good.

Joan Serra: There are always difficulties. Sometimes, they are related to our own limitations. We may be experts in one type of crop, such as corn, but we need the support of specialists with other specific knowledge, mycotoxins for example. Luckily, projects of this type put us in contact with each other.

You may also initially encounter somewhat protectionist approaches when you take on a subject. In our case, considering one variety to be not as good as another in a given aspect may create barriers in certain groups or companies, or shining a light on certain problems may be controversial, such as the presence of mycotoxins. Later, when you start work, you find that you are capable of cooperating with the various agents and making progress.

Màrius Simon: Our assessment is very positive. The work of the EIP-AGRI Operational Groups requires the collaboration of at least two agents. We are getting closer to the concept of Open Innovation, which I think is the best way of working in today's world. We are moving further away from an innovation model formed by isolated agents and closer to a growth model shared by production and tech companies, research centres and governments. This mix of types and profiles offers many advantages.

What is your overall opinion of the experience?

Ricard Carreras: Our experience with the Operational Groups has been very positive. I think that it has even improved in each call. One of the things we most appreciate is how simple the paperwork is. The inclusion of a coordinator makes it easier to carry out administrative work and meet deadlines. There are always things that need to be improved, but we will continue working in this direction.

Joan Serra: Overall, there is no doubt that it has been a good experience. The most gratifying thing is that a very high percentage of the research work is useful. This is easier when dealing with the actual problems of companies, as they themselves want tailor-made solutions and they apply them. Additionally, I would say that it is one of the easiest and simplest subsidy programmes.

Màrius Simon: After years of working in the sector on innovation projects, I would say that it is the best subsidy programme for R&D&I. It is the one we at the FCAC most recommend to cooperatives as an instrument to start or continue an innovation project.

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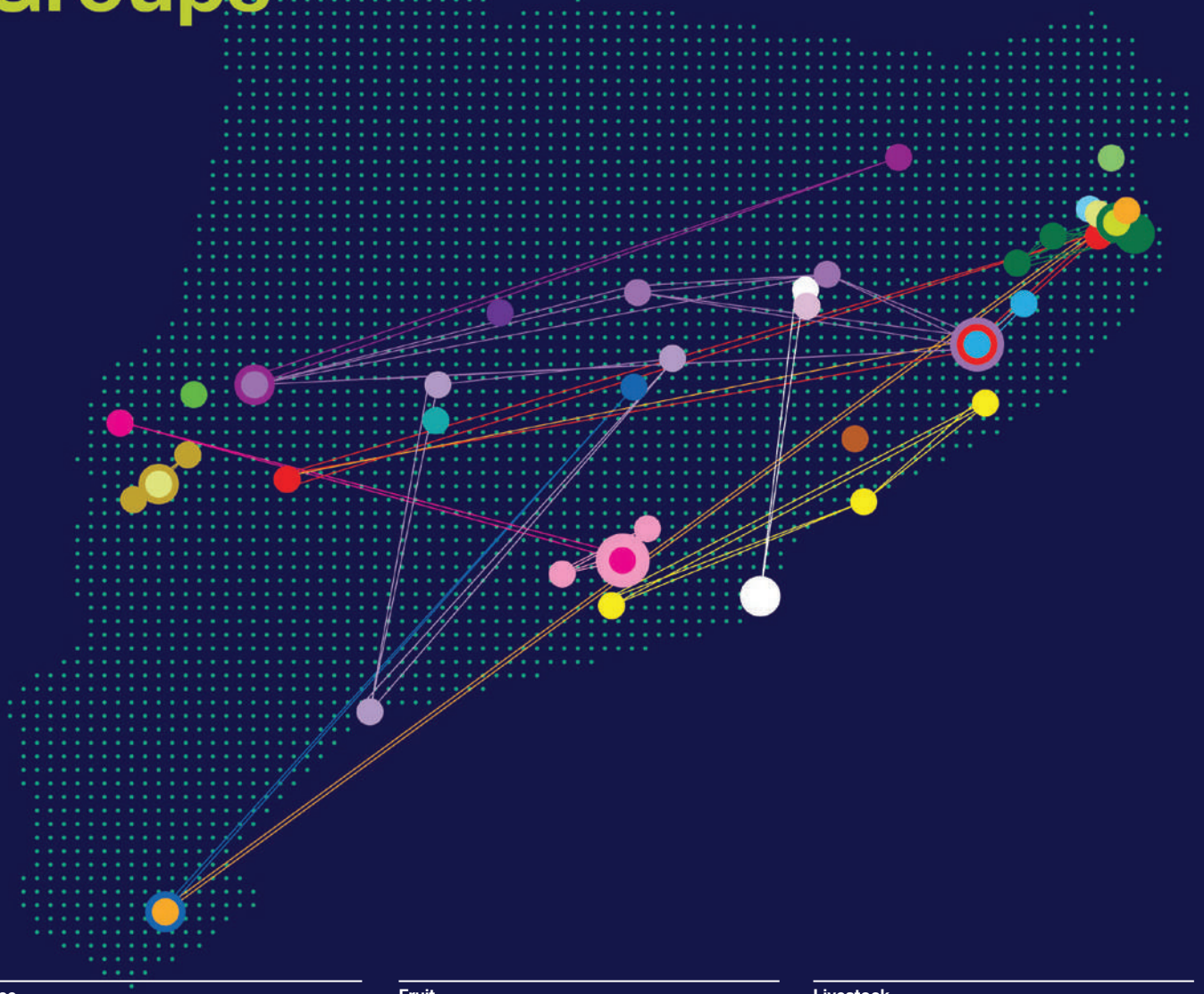
Operational Groups

2015



Rice

- Water saving in the cultivation of rice through the introduction of innovative agronomic techniques

Extensive crops

- Reduction of the mycotoxin content in corn in Catalonia

Forestry

- Improvement of the productivity and sustainability of black truffle plantations through the microbiological farming of the rhizosphere

Fruit

- Alternative to traditional fungicide treatments applied to post-harvest apples and pears
- Biological control of infestations at commercial apple plantations
- Control of *Monilia spp.* in stone fruit: use of prediction models and prophylactic methods
- New methods and technologies to prevent specific replant disease in apple trees
- New natural strategies to reduce post-harvest diseases in pip fruit.

Fruit

- New storage technologies and strategies for Golden Delicious and varieties of the Gala group

Market garden

- Integration of biological resources in horticultural production

Agri-food industry

- Extension of the shelf life in cold storage of vacuum packed pieces of beef to 84 days for exportation
- Implementation of an organic plot of traditional and resistant apple tree varieties, and resolution of weed and rodent problems
- Improvement of the technological quality of pork for the manufacture of cooked ham through optimal genetic selection
- Improvement of the end lipid products (fats) obtained from animal by-products to supply the local livestock sector.
- Pet treat production pilot test to add value to slaughterhouse by-products

Livestock

- Development of a slurry concentrator that continuously collects data on total nitrogen, phosphorous and organic matter in the two phases obtained
- Strategies to reduce the excretion of nitrogen in fattened calves during the finishing stage
- Pig fattening optimisation: feeding and product quality
- Reduction of the salmonella contamination rate in pigs
- Pig vaccination to reduce the prevalence of salmonella

Wine-making

- Vine phytosanitary treatment remote sensing and management system pilot test
- Profitability of the application of new technologies to achieve irrigation with maximum water efficiency at a pilot vineyard of 100 ha of organic and conventional vines

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The European Agricultural Fund for Rural Development:
Europe investing in rural areas