Precision agriculture for the improvement of winter cereal production and quality and its environmental sustainability

Summary

The implementation of *Decree 153/2019 (of 3 July, on the management of soil fertilisation and livestock manure and approval of the action programme in vulnerable zones in relation to nitrate pollution from agricultural sources)* provides for the need to reduce the P and K content of the soil when it exceeds certain stipulated levels. On the other hand, in the context of a need for local supply of raw materials for the manufacture of feed, it is necessary for suppliers (farmers) to receive adequate technical advice in order to achieve the production and quality standards of the product ordered, while preserving the environment at the level required (regulations, public opinion, etc.) in the society in which the production activity takes place.

The problems described above can be studied and solved thanks to precision agriculture, which provides exhaustive knowledge of the current state of the soil in order to apply the appropriate corrective measures. Specifically, in this project, six activities have been developed to adapt different precision agriculture techniques to improve the production of extensive crops.

Thanks to the vision provided by precision farming tools, precise fertiliser strategies can be created for more optimal crop management and at the same time more environmentally friendly. The transfer of information on this innovative methodology has been initiated in the sector through different dissemination actions carried out within the framework of this Operational Group.

Objectives

The main objective of the project is to create a new methodology for the management of crop fields through precision farming equipment, achieving maximum crop yields with the lowest possible environmental impact.

In order to achieve the general objective, it has been necessary to develop the following specific technical objectives, which are planned to be achieved within the framework of this project:

- To know the different characteristics of each plot by means of soil electrical conductivity sensors and yield monitors equipped with GPS positioning, as well as satellite images to obtain vegetation maps.
- Improve plot management through a thorough knowledge of these precision farming tools.
- Carry out different field tests with plots of the group to which the leader belongs, as well as with farmers who supply the raw material to advise them.
- Determine those strategies that can most favourably influence the reduction of P and K nutrient levels in the soil, in line with Decree 153/2019.
- To obtain a Guide for the reduction of P and K contents in agricultural soils for extensive crops, useful for different groups (administration, farmers, etc.).

- Implement a livestock manure application strategy, using NIR+GPS, as efficiently as possible. The technology applied will allow the precise definition of the nutrients needed in each part of the plot.

Description of the actions carried out in the project

In order to respond to the approach described above, the actions that form part of the project work plan, grouped by activity, are detailed below:

- ACTIVITY 1. Characterise the fertility and productive potential of plots of interest for the improvement of their management.
- ACTIVITY 2. Establish fertilisation strategies to obtain winter cereals with higher yields and quality.
- ACTIVITY 3. To reduce phosphorus (P) and potassium (K) levels in agricultural plots with a high content of these nutrients.
- ACTIVITY 4. Define the application of NIR+GPS technologies in the management of livestock manure using precision agriculture.
- ACTIVITY 5. To provide technical advice on the production of winter cereals.
- ACTIVITY 6. Carry out actions to transfer the results to the sector.

In line with Decree 153/2019, it was deemed necessary to carry out a study of plots where livestock manure has historically been applied in order to characterise them by means of precision agriculture and to provide a response to the sector's agents in the form of a strategy and a guide to advise them.

Final results and practical recommendations

Nitrogen is a key nutrient for plant species, therefore, accurate crop fertilisation, targeting areas of greatest need, translates into less impact from both an economic and ecological point of view. The results obtained from the maps of the various selected farms indicate a high degree of soil heterogeneity, possibly due to over-fertilisation over a number of years. All the maps obtained in the framework of this project have great potential for their 'operational' use in the context of precision agriculture, as the data extracted are used to produce a prediction map for each of the farms studied.

The results obtained have shown that the tools used in this operational group have been very useful for studying the cultivated area, where the differences between crops and areas with higher or lower chlorophyll (and consequently nitrogen) concentrations are clearly visible. With this technique, relevant information has been obtained to provide an overall picture of the condition of the farm, so that it can be very clearly identified which areas are in a more unfavourable state. It also provides valuable information for making management decisions such as determining sowing rates, the most appropriate fertiliser or plant protection product applications, the optimum harvest time or selection of the most suitable crop varieties, or those strategies that can have a more favourable impact on the reduction of P and K levels in the soil.

Fertilising crops with untreated excreta with N-fertiliser increases the P and K content of the soil, mainly because the composition of the excreta does not match the nutrient requirements of the crops. Therefore, the use of treatment effluents whose composition has a different nutrient balance can contribute to reduce this enrichment. The results obtained show that all effluents used provide more P (or the same) than untreated slurry. Therefore, they do not contribute to reducing the nutrient content of the soil. Other strategies that contribute to higher P withdrawals, such as introducing a second crop each year in the rotation, will have to be studied and introduced. An interesting option is the cultivation of leguminous plants, as they do not require N input and are also P and K extractors. In the case of plots with high K content, the use of Solid Fraction as a separator can be of interest in order to make lower K inputs than the extractions made by the crops and thus reduce soil K levels in the long term. The Liquid Fraction used shows less clear results, but is a material that should be studied in more detail. The rest of the effluents used, with N criteria, contribute excessive amounts of K, especially the NDN effluent.

Conclusions

Tests carried out with NIR + GPS technologies for the management of livestock manure show that the methodology is useful when carrying out precision fertilisation with livestock manure, allowing a differentiated application depending on the specific characteristics of each part of the plot. For its correct implementation, it is considered necessary to have tanks adapted to the technology, which allow a careful control of the applied dose. In addition to NIR and GPS control, it is necessary for the tank to have a regulation tap that automatically regulates the volume applied and allows the desired nutrient dosage to be adjusted, allowing the tractor speed to be maintained.

Thanks to the vision provided by precision farming tools, precise fertiliser strategies can be created for more optimal crop management and at the same time more environmentally friendly. The transfer of information on this innovative methodology has been initiated in the sector through different dissemination actions carried out within the framework of this Operational Group.

Leader of the Operational Group

ORGANISATION: ESPORC, SA

Coordinator of the Operational Group

ORGANISATION:

Other members of the Operational Group (grant recipients)

ORGANISATION:

Other members of the Operational Group (not recipients of the grant)

ORGANISATION: IRTA (Mas Badia)

ORGANISATION: Balmes University Foundation

Geographical area(s) of application

PROVINCE(S)	REGION(S)
Barcelona	Osona, Anoia
Girona	Alt Empordà
Lleida	Segarra

Dissemination of the project (publications, conferences, multimedia, etc.)

FIELD TRIPS

- Precision agriculture field day: variable sowing density. 9/2/2021. Calaf (Anoia).
- Precision agriculture field day: prescription maps from satellite imagery. 15/4/2021. Calaf (Anoia).
- XVIII inter-regional conference on arable crops. 20/5/2021. (Telematic day).
- Knowing the soil, a key tool for sustainable crop fertilisation. 1/12/2021. Ventalló (Alt Empordà).
- Precision agriculture field day: soil fertility and technology to apply variable doses of slurry. 8/2/2022. Gurb de la Plana (Osona).
- Workshop on mechanical weeding with a precision hoeing machine in winter cereals. 30/3/2022. La Tallada d'Empordà (Baix Empordà).
- Inter-regional conference on arable crops. 3/5/2022. Fornells de la Selva (La Selva).

RESULTS PRESENTATION SEMINAR

- RECOMEX 2021. 14/9/2021. (Webinar).
- RECOMEX 2022. Calaf (Anoia).

PUBLICATIONS

- "Guide for the reduction of phosphorus and potassium content in agricultural soils in extensive crops".

WEBCASTING AND SOCIAL MEDIA

https://apunt.uvic.cat/el-centre-tecnologic-beta-obte-quatre-noves-ajudes-del-programa-de-desenvolupament-rural-del-darp

https://www.linkedin.com/feed/update/urn:li:activity:6717697687690473472/

https://twitter.com/UDivulga/status/1313017294801580033?s=20

https://twitter.com/BETA_TechCenter/status/1311940427851993088?s=20

Project website

http://www.esporc.com/pdr-2014-2020/

More information on the project

PROJECT DATES	TOTAL BUDGET
Start date (month-year): July 2020	Total budget: €174,394.00
Completion date (month-year): September 2022	DACC funding: €69,583.21
Current status: Completed	EU funding: €52,492.59
	Own funding: €52,318.20

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Order ARP/133/2017 of 21 June, approving the regulatory bases for grants for cooperation for innovation by promoting the creation of European Association for Innovation operational groups in the areas of agricultural productivity and sustainability and the execution of innovative pilot projects by those groups, and Resolution ARP/1531/2019, of 28 May, announcing the call for the grant.

Generalitat de Catalunya
Departament d'Acció Climàtica, Alimentació i Agenda Rural

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