Strategies for improving the yield and value of the product derived from industrial hemp farming

Summary

The Industrial hemp crop is very resilient to different weather and rainfall conditions. Its short cycle (120-150 days) and its seasonality (spring-summer) offer the perfect combination for a rotation crop together with winter cereals and fodder crops, while yields can also be increased by reducing adventitious weeds and improving soil structuring. In addition, low water requirements (compared to crops such as maize) and the possibility of producing the crop in line with organic farming regulations (undoubtedly due to its low biotic stress level) make hemp a rotation crop with a higher added value for the producer, both economically and environmentally.

In 1998, industrial hemp farming in Spain for fibre and grain production covered an area of more than 16,000 hectares (according to MAPA data). Hemp by-products were mainly used for paper production, as building or bedding material for farm animals, for the fibre, as animal feed and as sowing seed for grain. All these uses provide low profits, which was probably one of the main reasons the crop was abandoned. The recent emergence of the bioplastics industry through the recovery of hemp fibre as the basis for the manufacture of a new generation of plastics, together with the use of the seed for human food linked to organic farm production, seems to have given a second life to the crop. However, the emergence of these new uses highlights the lack of studies correlating these production factors with quality traits now demanded for the products derived from this crop. Providing this knowledge, along with tools for quick and easy assessment of industrial hemp-derived products to guarantee their quality, is one of the critical points to advance rapidly towards a greater profitability for the crop and increasing the value of its derived products.

In this context, NIR (near infrared) spectroscopy has great potential for the quality control of raw materials obtained from hemp, not only because of its versatility, but also because it provides immediate results, thus speeding up decision-making in the field. Few NIR models related to hemp farming were found in the literature, and most of them focused on analysing cannabinoids in leaf flours. However, most of the models developed in the project had not been considered before, and therefore, beyond their future utility in the sector, they also represent a major advance in the study of the crop. Furthermore, developing these models should allow future trials to be carried out more quickly and cheaply, thus helping tackle larger-scale challenges on the improvement of the crop and use of the raw materials extracted.

Finally, having objective data on the cost-benefit analysis of hemp farms should make it easier for an increasing number of farmers to trust this crop as a good rotation alternative, as in many cases, lack of knowledge and lack of information generate distrust in taking the leap towards a new crop. Introducing this crop not only mains increasing farm profitability, but also represents a significant change in the water footprint of summer crops, considerably reducing their environmental impact.

Objectives

The main objective of the project was to develop tools to improve performance and, above all, improve the quality of the products derived from industrial hemp farming in Catalonia, so the crop can become

an agro-ecological alternative with low water demand as a summer rotation for winter crops such as wheat or fodder.

Description of the actions carried out in the project

1. Development of NIR prediction and classification models, which allow quick and easy analysis of agronomic and quality characteristics of the different usable parts of the industrial hemp plant: stalk (fibre), inflorescence and seed.
2. Carrying out field trials to determine the effect of different environmental factors on the yield and quality of fibre and grain in different certified varieties of industrial hemp, intended for use as fibre, biomass and/or grain.
3. Detailed economic study on the desirability of switching from maize to industrial hemp.

Final results and practical recommendations

A large number of NIR models were developed in the course of this project, most of which show the potential of this spectroscopic technique in monitoring the maturation and/or quality control of different raw materials obtained from industrial hemp. Some examples are the classification model for separating seeds that germinate from those that do not, the model for predicting the percentage fibre, which, together with data from the agronomic tests, facilitates indicative monitoring of the fibre maturation process, and the models for predicting most of the cannabinoids in hemp inflorescences, quantifying the acidic forms separately from the neutral ones. Extending some of these models or applying them to samples directly in the field (with portable equipment) is a good option for determining the status of a crop quickly and making immediate decisions.

For the agronomic results, data were obtained from two field trials in plots in the Empordà area of Girona. The first trial with different certified varieties calculated the fibre and grain yields, important components of the economic profitability of the crops. Despite the difficulty in obtaining reliable data on small plots, the results are comparable to those in the literature, which seem to indicate the adaptation of most of the varieties to our region, despite the low irrigation. The second trial studied the effect of various environmental factors (irrigation rate, seeding rate/seeder type) on the yield of two varieties, comparing it with data from the first experiment. Despite the large inter-annual variation, the best results seem to come from the single-seed drill, where a lower seeding density and using support irrigation. Both trials also studied the development of several fibre quality parameters during the growth and maturation process of the plants, providing an idea of the trends in each parameter over time and the correlations between them. This was particularly useful for us when approaching the NIR models for fibre.

A comparative economic study was also carried out comparing the farming of industrial hemp and maize, two crops that are very similar in terms of cycle and management requirements, which could therefore be more easily interchangeable. The costs and revenue in both cases were analysed in detail, assessing also the different use and irrigation cases for hemp (use of fibre, grain, or both, in dry and irrigated land), also calculating the margins generated from the sale of the product. In all cases, there was a positive balance between cost and revenue. In the case of hemp, production of high-quality fibres for the textile industry in irrigated fields was the most profitable model (2020 data) while maize farming had the highest gross margin (2022 data), although not that much higher than hemp.

In conclusion, the actions carried out in this project provided a fuller understanding of industrial hemp farming and its management and adaptation to the region, but always with a view to maximising the yield and value of the derived products. Firstly, NIR spectroscopy analysis tools were developed to permit rapid monitoring of crop status and/or the quality of the derived products, helping to maximise production and guarantee the quality of derived products. Secondly, experimental field trials were carried out, comparing the effects of environmental factors such as irrigation dose and sowing density, which has a direct impact in minimising the costs associated with the crop (both economic and environmental). Finally, a comparative economic study was presented showing that hemp farming has similar profit margins to maize.
Thus, the knowledge generated in this project aims to show the potential of hemp as a summer rotation crop. And although maize is currently more profitable, the application of the tools and knowledge generated by the study, together with the intrinsic advantages of the crop and expansion of the sector, could turn the situation around.

Conclusions

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Leader of the Operational Group

ORGANISATION: Planteles Lloveras, SL

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: Miquel Agustí Foundation

ORGANISATION: Ibercànem

ORGANISATION: Girona Association of extensive crop producers (APCEGi)

Geographical area(s) of application

PROVINCE(S)	REGION(S)
GIRONA	Alt Empordà and Baix Empordà

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

Scientific publications:

- "*Sample preparation effects on near infrared (NIR) data of acidic and neutral model forms of cannabinoids in* Cannabis sativa *flowers*" - Publication as a poster, presented at the 17th RNE- 11th CIE congress (Malaga, 5-8/07/2022).
- Results to be published in a scientific article

PATT conferences:

- "Raising the value and use of industrial hemp: current situation and future opportunities" (06/09/2022)
- "Hemp management and harvesting machinery for dual use of fibre and grain" (29/09/2022)

Multimedia:

- Manual of good practices in industrial hemp farming for dual use in irrigated agriculture
- Catalogue of information files on the varieties of industrial hemp tested

Progress of the project updated on the Miquel Agustí Foundation website, Twitter (@FMAoficial) and Instagram (@fmaoficial).

Project website

https://fundaciomiquelagusti.cat/projectes/estrategies-de-millora-del-rendiment-i-valoritzacio-del-producte-derivat-del-cultiu-del-canem-industrial/

More information on the project

PROJECT DATES	TOTAL BUDGET
Start date (month-year): July 2020	Total budget: €122,867.50
Completion date (month-year): September 2022	DACC funding: €65,119.78
Current status: Completed	EU funding: €57,747.73
	Own funding: €52,657.50

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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.

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