

DURCAT: Meeting the demand for durum wheat through local production with low environmental impact, short distribution chains and total traceability

Summary

The aim of the project was to contribute to introducing durum wheat into Catalonia as a new value-added alternative for the cereal sector, by implementing a quality-oriented production model and a short distribution chain, while also addressing the Catalan pasta industry's demand for durum wheat. The project was carried out during the 2018-2019 and 2019-2020 agricultural seasons. In order to establish the productive potential of durum wheat in different Catalan agro-climatic zones, under different levels of irrigation and agronomic management, production and quality of durum wheat grain from various varieties and advanced lines were evaluated for two years in various types of pilot fields. To assist in decision-making, innovative tools based on remote sensing and sensorisation were applied and a study was carried out on the environmental impact of grain production and transport under various production and agronomic management scenarios. Finally, the economic viability of durum wheat farming in different areas was determined by identifying the technical requirements for creating a short field-to-industry distribution chain with a high quality product, local production and full traceability.

Objectives

The general objective of the DURCAT project was to contribute to introducing durum wheat into Catalonia as a new value-added alternative for the cereal sector by implementing a quality-oriented production model and a short distribution chain, while also addressing the Catalan pasta industry's demand for durum wheat. To do this, the following specific objectives were set:

1. Establish the productive and qualitative potential of durum wheat in Catalonia by identifying the most suitable varieties for each production area.
2. Apply innovative tools to support decision-making based on remote sensing and sensorisation, for environmentally friendly and economically sustainable quality grain production.
3. Create a short field-to-industry distribution chain integration model.
4. Assess the environmental and economic impact of the proposed production model.

Description of the actions carried out in the project

To establish the **productive potential of durum wheat**, agro-climatic zones where durum wheat farming might be a viable option were identified. These were the irrigated areas of the Aragon and Catalonia canals (Sucs), the Segarra-Garrigues canal (Foradada), the semi-temperate drylands (Artesa de Segre and Santa Coloma de Queralt) and arid and semi-arid drylands (Alguaire). During the first campaign, 21 durum wheat varieties were evaluated in each of these areas and compared to high-production controls of wheat for flour, barley and triticale. In the town of Sucs, the impact of water availability on grain yield and quality was also studied. From the results for the first year the potentially better adapted varieties to each cultivation zone were selected and sown in each agro-climatic zone in pilot strips in the second year of the project. In addition, the three most promising varieties in the Aragon and Catalonia canals irrigation zones and the semi-temperate drylands were planted in large field demonstrations where two agronomic management systems were compared: the standard system used by farmers for flour wheat in each area and the optimum system in terms of nitrogen fertilisation and irrigation, if required. In all the plots, the agronomic behaviour and quality of the grain obtained were assessed. At the time of writing, factory evaluations on the quality of the pasta obtained are being carried out.

A study was conducted to determine the **economic viability of durum wheat cultivation in Catalonia** based on production results in each agro-climatic zone in each season, under the following premises: i) considering similar production costs for durum wheat and alternative cereals, and ii) using the farmers' market price for grain at the Cordoba agricultural product wholesale market on 13 October 2019 for the TD1 quality group in the first season and 20 August 2020 for prices of the TD3 Group in the 2020 season.

The application of **innovative tools to support decision-making** focused on the plots in Sucs where the behaviour in different irrigation regimes was studied in 2019. In 2019, three drone flights were performed, during which various parameters were measured to calibrate and verify the remote sensing tools. In 2020, the activities involved weekly monitoring of the state of the crop using Sentinel 2 satellite images. These images were used to calculate vegetation indices. Over the two years, weekly irrigation was planned based on meteorological data, verified by data obtained from remote sensing.

A life cycle analysis was carried out to **quantify the environmental footprint** of dry pasta production using durum wheat grain grown in Catalonia, taking a complete agri-food chain approach and focusing on all potential environmental effects. The primary data on agricultural activity were obtained from the project fields themselves and the secondary data came from specific databases. Various sensitivity analyses were conducted to estimate the influence of irrigation quantity, crop yield and field distance from the factory.

In creating a field-to-industry **short distribution chain integration model**, two major shortcomings in the current system were identified: a quantitative shortcoming, due to insufficient availability of durum wheat grain to meet industry demand in Catalonia, and a qualitative shortcoming, due to the insufficient quality of grain currently produced in the areas closest to Catalonia. Subsequently, the strengths and weaknesses of the system were detected, identifying the technical requirements for implementing the model.

Final results and practical recommendations

On the estimated production potential and the most suitable varieties for each agro-climatic zone:

- Aragon and Catalonia Canal irrigation zone: Under optimal farming conditions and with a quantity of water of 449 mm in the 2019 campaign, the best durum wheat was the 'Euroduro' variety, which produced 10,714 kg ms/ha, a yield similar to the 'Marcopolo' flour wheat (10446 kg ms/ha) and 'Scrabble' barley (9422 kg ms/ha). In 2020, with 533 mm of water, the best durum wheat was the 'Wing' variety (7012 kg ms/ha), which had a lower yield than 'Marcopolo' (7936 kg ms/ha) but a higher one than 'Scrabble' (6010 kg ms/ha). In the field demonstration in 2020, using 470 mm of water, yields ranged from 4423 to 7477 kg ms/ha, corresponding to the 'Euroduro' variety subjected to standard agronomic management and the 'Anvergur' variety, subjected to optimal management.
- Segarra-Garrigues Canal irrigation zone: in the first year, with 322 mm of water, the 'Grador' variety was the most productive, with a yield of 7340 kg ms/ha, a significantly lower value than for the flour wheat 'Marcopolo' (8683 kg ms/ha) and 'Scrabble' barley (8424 kg ms/ha). In the following year, with 443 mm of water, the yield of the best durum wheat ('Claudio') was 5497 kg ms/ha, similar to 'Marcopolo' (5670 kg ms/ha), and 'Bondadoso' triticale (4970 kg ms/ha), but higher than 'Scrabble' barley (3893 kg ms/ha).
- Temperate drylands: In 2019, with 144 mm of rainfall, the best durum wheats in terms of production were the 'Athoris' and 'Sculptur' varieties, with yields of 4357 kg ms/ha, similar to 'Bondadoso' triticale (3963 kg ms/ha) but significantly higher than 'Gustav' barley (2755 kg ms/ha). In 2020, with 402 mm of rainfall, 'Calero' was the best durum wheat in this area, with a production of 6872 kg ms/ha, higher than 'Lagalia' barley (5924 kg ms/ha) and 'Bondadoso' triticale (4824 kg ms/ha). In the field demonstration, where rainfall during the season was 510 mm, the yields ranged from 5003 to 6304 kg ms/ha, obtained in the 'Sculptur' variety subjected to both standard and optimal agronomic management.
- Dry arid and semi-arid: In 2019, under a rainfall of 78 mm during the season, the production of several varieties of durum wheat was similar to that of 'Bondadoso' triticale (2776 kg ms/ha) and 'Gustav' barley (2354 kg ms/ha), with no significant differences between these two controls. In 2020, with a

rainfall of 350 mm, the best durum wheat was the 'Euroduro' variety which produced 5882 kg ms/ha, while the 'Asteroid' control yielded 6690 kg ms/ha and 'Bondadoso' triticale produced '6748' kg ms/ha.

On grain quality. Grain quality was excellent in 2019, reaching protein levels above 18% and specific weights above 85 kg/hl in many varieties and locations. The vitreousness was very high and the overall quality index of EU durum wheat was higher than that of the official control for all the varieties evaluated, whose grain was commercially categorised as TD1, corresponding to the best commercial category group. Grain quality was much lower in 2020 due to continuous rains during grain filling, which lowered the values of the quality variables most affected by environmental conditions: vitreousness, specific gravity and protein content. Overall, in the fields overall in 2020, qualities were limited to commercial wheat groups TD2 and TD3. The 'Burgos', 'Grador', 'Euroduro', 'Carpio' and 'Sculptur' varieties and the '09D069' experimental line stood out for their quality.

On the effect of the water regime on durum wheat production: the average yield of the durum wheat evaluated during the first season was heavily affected by water availability (9129 kg ms/ha, 449 mm during cultivation, 7534 kg ms/ha, with 285 mm, and 4793 kg ms/ha, with 122 mm).

On the economic viability of durum wheat production in Catalonia. Economic analyses showed that durum wheat is an economically viable alternative in Catalonia even in unfavourable years, when weather conditions can have a negative impact on grain yield and quality. The reason for this is that although the yield of durum wheat was lower than that of other cereals under certain conditions, the higher price for its grain compensates the producer financially, even giving a higher margin, which compensates for the higher productions cost, if such were the case.

On the application of innovative tools to support decision-making. Crop height estimates from remote imaging correlated significantly with field measurements, obtaining a coefficient of determination, R^2 , of 0.95. Leaf area index (LAI) estimates using the MTVI2 index also correlated closely to field ceptometer measurements ($R^2 = 0.785$) with low saturation at high LAI values. The two-source energy balance (TSEB) model allowed the amounts of water transpired by the crop (T) and lost by evaporation to be estimated. The results of the study show that there is a clear genotype effect for T and LAI under water stress conditions. In addition, a high correlation was found between gross primary production and T in the grain filling phenological stage. No significant correlation was found between quality parameters and transpiration.

About the environmental impact evaluation. Water management was identified as one of the most critical aspects in durum wheat production. Thus, the Aragon and Catalonia Canal irrigation scenario, with Sucs as the representative locality, offers the most environmentally promising option. With regard to diesel consumption, the high number of soil tillage operations, particularly in this location, means that it has the highest the impact, which is not fully offset, even in the case of maximum production. The importance of fertilisation was demonstrated due its large number of impacts. This aspect requires more detailed studies, including replacing some of the mineral fertilisers with organic ones. With regard to climate change, there was a general trend showing a lower impact in the Sucs scenario, especially due to its higher yield.

The importance of yield in calculating impact in most categories analysed was demonstrated. In this sense, the semi-temperate drylands and the Sucs drylands, and providing half the water needs for the crop were shown to have the best environmental performance. Comparison of impact points per hectare shows a higher contribution from irrigation, especially due to the significant impact of water consumption, which is justified in the case of higher production in the two Sucs irrigation scenarios in 2019. On the contribution of field-to-industry grain transport, the results show the potential importance of distance on the final impact, rising from an impact of 30 g CO₂ eq per kg of pasta for local transport to 250 g CO₂ eq per kg of pasta at the maximum assessed distance of 1200 km from field to industry.

On the creation of a short field-to-industry distribution chain integration model. The first step in creating a short-chain model is this relationship and connection with the research established through the DURCAT Operational Group. In this sense, not only the varieties considered the best

and already registered in Spain and France but also experimental varieties from the Institute of Agrifood Research and Technology (IRTA) were evaluated. The lower quality grain obtained in the second year of the project meant that not all the grain was suitable for industrial use, as a third of it failed to reach the minimum required by the Gallo brand to guarantee its inclusion in the production process. However, industry use of two thirds of production is considered satisfactory, given the price differential compared to animal feed, in a year of an abnormal climate conditions, which was not representative of the areas where the field demonstrations were set up. The industrially viable crops are within a radius of 100 to 150 km of the production centre, which significantly reduces road transport and the corresponding carbon footprint, and creates added value that can be shared by farmer and industry, thanks to lower transport costs.

The concept of a pasta produced wholly in Catalonia, from varietal development to the marketed end product, has not been implemented until now. The technical results obtained in both years of crops in the DURCAT project validate varieties with a yield that makes the crop attractive to the primary sector, and with a quality that makes them suitable for 1st and 2nd transformations. It is no exaggeration to say a process can be designed that would allow us to certify a pasta as guaranteed 100% Catalan in origin. This might not yet be made by the largest pasta factory in Catalonia (Gallo), but by medium-sized or more artisan production units, of which there is a well-established representation in the region.

Producers who grew durum wheat in the second year of the DURCAT project were able to provide full traceability for the crop, fertiliser records, phytosanitary applications, when necessary, and all field notebook documentation to provide a level of traceability higher than at large sea imports, where unification at port means there is less individualised traceability than can be provided by local farms.

Conclusions

- The production potential of durum wheat in each agro-climatic zone was determined on the basis of two climatically very different agricultural seasons. In irrigated environments, the durum wheat yield was comparable to that of barley but lower than that of long-cycle, high-productivity flour wheat. In semi-temperate drylands, the durum wheat yield was comparable to that of the barley and triticale used as controls. In arid drylands, the durum wheat yield was generally lower than that from these species. However, the higher price for durum wheat makes it an economically viable alternative in Catalonia.
- The excellent quality of the durum wheat obtained during the 2019 season showed that it is possible to produce durum wheat of the highest quality (Type 1) in Catalonia with proper irrigation and surface nitrogen fertilisation cover. Although quality may be lower in seasons such as 2019-2020, this does not endanger the economic competitiveness of durum wheat compared to other cereals, due to the higher price of its grain.
- The major climatic differences, fundamentally in terms of rainfall, between the two campaigns meant the best varieties of durum wheat for each agro-climatic zone could not be identified with sufficient reliability from the results. Data from more seasons is required to provide conclusive results.
- Use of multispectral and thermal remote sensing, supported by energy balance models, made it possible to determine the height of the plants, the fraction of vegetation cover, the LAI, crop evapotranspiration and transpiration and relate them to production variables.
- Remote sensing tools were useful for both implementing irrigation strategies tailored to each stage of the crop and for selecting varieties adapted to irrigation restrictions.
- In environmental terms, durum wheat production in Catalonia has excellent potential. However, the different scenarios considered in terms of production and agronomic management presented a very wide range in terms of environmental impact, so it would be advisable to carefully select the best options, especially with regard to irrigation.
- The G.O. DURCAT project served to validate the value chain, from obtaining the variety to marketing the product to the end consumer. For each of the five steps in the

production circuit there are associated measurable and tangible (as well as emotional and intangible) benefits:



- It seems unlikely that Catalonia can achieve self-sufficiency in durum wheat, given that production of 150,000 tn/year would require farming in areas where weather and soil are not particularly suitable, but a production level of about 10-12,000 tn/year is a realistic target, which would add value to the primary sector and be highly marketable.
- Even if domestic demand in Catalonia was lower than at present, a high-quality durum wheat would have an outlet (while still maintaining economic and proximity criteria) in the Aragon semolina industry.
- However, this requires a commitment from the primary sector to implement a more demanding technical pathway when compared to more rustic cereals, such as barley. Added value is not automatic and requires training and increased technology among farmers investing in the introduction of durum wheat in their rotations.
- The quality of the wheat obtained allows the integration of Catalan-produced durum wheat into large producers' mixtures and its industrial use in competitive conditions, such as the creation of a segregated production chain that guarantees durum wheat-based products with fully guaranteed traceability and a locally grown seal.

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Subject area(s) of application

- Agricultural production system
- Agricultural practice
- Agricultural equipment and machinery
- Livestock farming and animal welfare
- Vegetable production and horticulture
- Landscape / Territorial management
- Pest and disease control
- Fertilisation and nutrient management
- Soil management
- Genetic resources
- Forestry
- Water management
- Climate and Climate Change
- Energy management
- Waste and by-product management
- Biodiversity and environmental management
- Food quality/processing and nutrition
- Supply chain, marketing and consumption
- Competitiveness and agricultural and forestry diversification
- General

Geographical area(s) of application

PROVINCE(S)	REGION(S)
Cereal growing areas in the four Catalan provinces	All cereal-growing areas, especially L'Urgell, El Segrià, La Segarra, El Vallès Oriental, El Pla d'Urgell and La Noguera

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

The results of the project have been disseminated through the following transfer activities:

- Two press releases in October 2018 disseminated via the IRTA communication department.
- Radio broadcast on several occasions of an interview on Catalunya Radio with Conxita Royo about the GO DURCAT project on 20 November 2018.
- An explanatory note in Irrigation Office newsletter 40 in September 2019.
- Organisation of three Annual Technology Transfer Plan (PATT) Conferences:
 - o 1st Conference (5 June 2019) - Presentation of the DURCAT Operational Group.
 - o 2nd Conference (5 March 2020) - Crop management and presentation of the results from the first project season.
 - o 3rd Conference (19 May 2020, online) - Production of high yield and quality durum wheat: precision agriculture technologies and environmental impact.
- An article in RuralCat on 26 September 2019.
- Three articles in the Catalan Ministry of Agriculture, Livestock, Fisheries and Food (DARPA) Technical Dossier:
 - o Royo C, Villegas D. 2020. "El Blat Dur, alternativa de cultiu típicament mediterrània". *Technical Dossier* 101: 3-8.

- https://ruralcat.gencat.cat/documents/20181/7280382/DT+101_WEB_Baixa.pdf/9e3ea4c9-1814-4dca-9432-c18ec7e7f18e
- Royo C, Villegas D, Álvaro F, Bellvert J, Vallverdú X, Anton A. 2020. "Impuls del blat dur a Catalunya – projecte Grup Operatiu DURCAT". *Technical Dossier* 101: 9-12. https://ruralcat.gencat.cat/documents/20181/7280382/DT+101_WEB_Baixa.pdf/9e3ea4c9-1814-4dca-9432-c18ec7e7f18e
 - Gómez D, Royo C. "Fenotipat dels cultius extensius mitjançant eines de teledetecció". *Technical Dossier* (In press).
- A scientific article is currently being drafted and will be published in a high-impact journal and several demonstration publications are planned to present the project results.
 - Dissemination of the project and its activities through the IRTA website and others:

<http://www.irta.cat/ca/projecte/durcat-projecte-pilot-innovador-per-promoure-labastiment-de-la-demanda-interna-de-blats-dur-amb-produccio-de-proximitat/>

<http://www.irta.cat/es/activitat/impulso-del-trigo-duro-en-cataluna-g-o-durcat/>

http://www.redruralnacional.es/documents/10182/546214/INICIAL+PILOT+GO+2017_006_GALLO_CAST.pdf/447f7091-bdc6-4c3d-ad3a-16b5c2c3d89e

Project website

http://www.redruralnacional.es/documents/10182/546214/INICIAL+PILOT+GO+2017_006_GALLO_CAST.pdf/447f7091-bdc6-4c3d-ad3a-16b5c2c3d89e

More information on the project

PROJECT DATES	TOTAL BUDGET
Start date (month-year): June 2018	Total budget: €177,396.57
Completion date (month-year): September 2020	DARP funding: €72,498.24
Current status: Executed	EU funding: €54,691.66
	Own funding: €50,206.67

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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/1868/2017, of 20 June, announcing the call for the grant.



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Departament d'Agricultura,
Ramaderia, Pesca i Alimentació



Fons Europeu Agrícola
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Europa inverteix en les zones rurals