

## Promotion of the production of barley, maize, alfalfa and oilseed crops in organic production of animal feed

### Summary

This Operational Group was established to promote the production of raw materials to obtain locally produced organic feed.

The demand for feed made from certified raw materials is currently increasing sharply. Local production levels are insufficient to meet this demand, and the processing industry has to be supplied from outside Catalonia, which has created a problem of uncertainty in a production system where proximity can be a requirement. For this reason, most feed companies believe that promoting the local production of crops such as cereals (barley, wheat, etc.), legumes (alfalfa, etc.) and oilseeds (rapeseed, soya, etc.) is a strategic factor. Organic producers need to improve their production processes and introduce new technologies and innovations in order to be competitive.

This Operational Group was established to promote the production of raw materials to obtain locally produced organic feed. The Group is led by NUTREX PINSOS, S.L., a company specialising in feed production, with an increasingly extensive portfolio of organic farmers.

### Objectives

The overall aim of the project is to promote the production of local raw materials for the manufacture of feed for livestock feed, and in particular barley (*Hordeum vulgare*), maize (*Zea mays*), alfalfa (*Medicago sativa*), rapeseed (*Brassica napus*) and soy (*Glycine max*), in the organic production system.

The following specific technical objectives were set:

- Determine the agronomic practices, costs and quality involved in current local organic production of barley, maize, alfalfa and rapeseed.
- Study the feasibility of rapeseed cultivation in organic production systems.
- Assess the adaptation of new varieties of barley, maize and soy to organic production systems.
- Improve the management of nitrogen fertilisation in the production and quality of barley and maize.
- Transfer the results obtained to the sector.

### Description of the actions carried out in the project

The following actions were carried out in order to achieve the objectives set out in the framework of the project:

**Activity 1. Monitoring of organically cultivated plots belonging to farmers producing barley (*Hordeum vulgare*), maize (*Zea mays*) and alfalfa (*Medicago sativa*)**

During the first activity, several plots of organically produced barley were monitored by different farmers in the main cereal-producing areas in the provinces of Girona and Barcelona during the 2019-20 and 2020-21 campaigns, and the various cultural practices of the plot, its yield and grain quality were recorded, among other parameters. Various plots of organically produced maize in the Vallès Oriental, Garrotxa and Alt Empordà regions belonging to different farmers were also monitored, and various parameters of interest were recorded. Finally, the plots belonging to organic alfalfa farmers in the Pla de l'Estany region were monitored.

**Activity 2. Study of the agronomic feasibility of rapeseed cultivation in organic production systems**

Various farmers' rapeseed plots subject to different management systems were monitored in order to determine the main factors that affect this type of crop in organic production systems. Cultural practices, weeding efficiency, biomass at the end of winter, the pressure of the various pests that affect rapeseed and the yield and quality of the grain in the harvest were assessed.

**Activity 3. Assessment of new varieties of barley (*Hordeum vulgare*) and maize (*Zea mays*) in the organic production system**

During the third activity in the project, two trials were carried out in the Pla de l'Estany region in the 2019-20 and 2020-21 campaigns, involving sowing different varieties of barley with different genetic traits. Furthermore, two trials were carried out in the Alt Empordà region during the 2020 campaign, in which various varieties of maize were studied and the main parameters of interest were analysed.

**Activity 4. Impact of nitrogen fertilisation on the production, quality and health of barley (*Hordeum vulgare*) and maize (*Zea mays*)**

The fourth activity in the project mainly involved evaluation of the effects of the contributions of nitrogen to the production and the quality of the grain. Various tests were carried out on each crop of barley (conventional and hybrid) and maize, in plots in the Pla de l'Estany and Alt Empordà regions.

**Activity 5. Assessment of the agronomic viability of soy (*Glycine max*) cultivation in organic farming**

A test with 10 varieties of soy with different cycles was carried out during the 2020 campaign in the town of Sucs (Lleida), and the implantation of the crop and other parameters of interest were assessed. An organically cultivated soy plot was monitored during the 2019 and 2020 seasons, and various parameters were assessed during the development of the crop and after the harvest.

**Activity 6. Transfer of the results**

During the last activity, several technical and field seminars were organised to inform the sector about the actions carried out and the results achieved within the framework of this project.

## Final results and practical recommendations

### Activity 1. Monitoring of organically cultivated plots belonging to farmers producing barley (*Hordeum vulgare*), maize (*Zea mays*) and alfalfa (*Medicago sativa*)

During the 2019-20 campaign, the average production of the five plots of barley that were harvested for grain was 2.144 kg/ha, the highest humidity level was recorded in the plot in La Garrotxa, and a very low specific weight was observed in all the plots. However, a high content of aflatoxins and deoxynivalenol was only detected in the plot in Hostalets d'en Bas.

During the 2020-21 campaign, the average yield of the eight barley plots was 3,561 kg/ha, with the highest production level observed in the plot in Sant Antoni de Vilamajor. The average humidity at the time of harvest on all the plots was 10.6%, while the hectolitre weights were higher than in the previous season, and no high levels were observed for any of the mycotoxins analysed.

In the maize plots, the highest production levels during the 2019 campaign were observed in the Vall d'en Bas plot, and the Sant Antoni de Vilamajor plot was the only one contaminated by mycotoxins, which were mostly deoxynivalenol.

Finally, in the 2020 campaign, the two fodder plots produced an average of 41.5 t of green matter/ha, while the other two plots produced 11,150 kg/ha of grain.

#### Practical recommendations:

For organic barley, late sowing is recommended in December and January to avoid excessive weed infestations, and a higher planting density than in conventional production is also recommended. Precision hoes are more efficient in mechanical weeding, and a separation between rows is therefore recommended to enable this machinery to be used.

It is necessary to delay sowing maize so that the flowering does not take place at the same time as in any possible nearby fields of genetically modified maize, thereby avoiding cross-pollination. This means that it is advisable to sow short cycle varieties that can be harvested in October and November.

### Activity 2. Study of the agronomic feasibility of rapeseed cultivation in organic production systems

A standard crop implantation was observed during the 2019-20 campaign, as well as a percentage of aphid damage of around 20 and 30% of plants affected in the early stages of the crop, and a very high level of weed infestation. Although the crop had good vegetation levels, the number of weeds was very high at the end of winter.

The beetles captured were mostly *Meligethes* sp., *Ceutorhynchus pallidactylus* and to a lesser extent, *Ceutorhynchus assimilis*.

During the 2020-21 campaign, the plots were severely affected by aphids during the early stages of the rapeseed's development, with up to 120 specimens captured in one week, and up to 100% of the plants were affected in some plots. A significant relationship was also observed between the date of sowing and the biomass at the end of winter, as excessively late sowing dates had an effect on obtaining the desired amount of biomass at the end of the winter.

Very high levels of weed infestation were observed, which were mainly sea barley. The hoes brought the weeds under greater control, although none of the plots had a weed population that was below acceptable levels.

Finally, the main beetle pests affecting rapeseed were *Ceutorhynchus pallidactylus*, *Ceutorhynchus napi*, *Ceutorhynchus assimilis* and *Meligethes* sp. The greatest pressure was observed with pollen beetles, with around 800 specimens recorded in a week. The yield may also have been affected by the cabbage seedpod weevil (*Ceutorhynchus assimilis*) which bites into the pods where the brassica pod midge *Dassyneura brassicae*) subsequently lays its eggs, and the larvae eat the still tender grains when they emerge.

#### Practical recommendations:

In order to achieve a good harvest yield, it is important to reach the end of winter with a biomass higher than 1.5 kg of rapeseed /m<sup>2</sup>. This means that sowing should not take place too late, and sowing too early should also be avoided to prevent excessively high weed infestation.

Strategies to reduce damage by aphids in the early stages of crop development, and pollen beetles during flowering must be put in place.

### **Activity 3. Assessment of new varieties of barley (*Hordeum vulgare*) and maize (*Zea mays*) in the organic production system**

During the 2019-20 campaign, significant differences in plant cover were observed between the barley varieties sown, with the lowest cover observed in the ZOO variety (a hybrid variety with a lower sowing density). However, the varieties with the highest plant cover were LAGALIA, FATIMA and KWS FANTEX, while ZOO, SIGNORA, RGT PLANET and LG AUSTRAL were the varieties with the tallest plant height. There was a widespread brown leaf spot attack by (*Dreschela teres* and *Ramularia collo-cygni*) with severity levels of over 25% of the leaf area affected in all varieties, with less damage in the KWS FANTEX, LG NABUCO, RGT PLANET and SIGNORA varieties. The most severe cases of wheat leaf rust were observed for LG NABUCO, RGT PLANET and KWS FANTEX. The average yield of the test was 3,232 kg/ha, and significant differences were observed between the yield of varieties.

During the 2020-21 campaign, the varieties with the most ground cover were LAGALIA, RGT PLANET and LAUREATE, and the varieties with the tallest plants were FOCUS, JALLON, LAVENDER and LAUREATE. The brown leaf spot attack affected the crop to the greatest extent, with severity levels of 35% and 40% of the leaf area affected in the most sensitive varieties, which were BASIC and SIGNORA respectively, while JALLON and MESETA were the most resistant varieties. No significant differences in yield were observed between varieties during this campaign. Finally, the average humidity of the test at harvest was 10.3%, and higher hectolitre weights were detected than in the previous season, with an average of 64.8 kg/hl.

Both campaigns showed that the varieties that simultaneously presented good plant cover and tall plants were KWS FANTEX, LAGALIA, SIGNORA and RGT PLANET. Brown spot and wheat leaf rust were the two most frequently observed foliar diseases, with JALLON, MESETA and FOCUS being the most resistant varieties, and LG NABUCO, KWS FANTEX, LG AUSTRAL, RGT LUZIA and SIGNORA the most sensitive varieties.

A very large percentage of damage by *Helicoverpa* sp. was observed in the evaluation of new varieties of maize, especially in Castelló d'Empúries, where an average of 0.2 larvae per cob were found, while the damage caused by borers was higher in Torroella de Fluvià, where an average of 0.12 larvae per plant were found. A tendency was observed in the 500 cycle varieties to show present vegetative vigour at the 5-leaf stage, and the productive behaviour at harvest was similar in the longer cycle and shorter cycle varieties.

Of the nine mycotoxins analysed, the most frequently observed with the highest content were fumonisins.

#### Practical recommendations:

It is important to select barley varieties with characteristics that allow them to compete better with weeds, such as vegetation cover during the early stages of development and plant height. Because fungicides cannot be applied, it is necessary to sow varieties that are resistant to the main leaf diseases, and especially to the complex of brown spots which affects the crop to the greatest extent, and wheat leaf rust to a lesser extent.

For maize, it is useful to have plants with greater vigour in the early stages of cultivation, to reduce damage by pests and to some extent, to compete better with weeds; this is easier to achieve with shorter cycle varieties, as their vegetative development is faster. Factors to take into account when trying to reduce the risk of infection by mycotoxin-producing fungi include the varieties' resistance to insect damage. The height of the varieties is important in situations with very strong pressure from borers, especially in areas with strong winds, and it is important above all not to delay the harvest for too long.

#### **Activity 4. Impact of nitrogen fertilisation on the production, quality and health of barley (*Hordeum vulgare*) and maize (*Zea mays*)**

During the 2019-20 campaign, the average yield of Basic barley was 3,349 kg/ha at 13% moisture, and the average specific weight was 51.5 kg/hL. The nitrogen fertilisation led to no significant variations in the nutritional status of the plant at the flag leaf cultivation stage, just before the start of earing, or in the height of the crop. For ZOO hybrid barley, the average yield was 3,109 kg/ha at 13% humidity and an average specific weight of 47.1 kg/hL. The average protein content was 12.6%, and in the treatments that received nitrogen in the blanket it was 12.9%, while the average starch content was 41.8%. Hybrid barley was longer (115.1 cm on average) than conventional barley (94.9 cm). The greatest susceptibility to leaf diseases (90%) was observed in the conventional variety (Basic), while the hybrid variety (Zoo) had a lower incidence (45%) than the conventional one (Basic). Finally, low temperatures affected both barley varieties to the same extent, although the treatments in which fertilisation was applied were less affected by low temperatures.

During the 2020-21 campaign, an average yield of Meseta conventional barley of 5.379 kg/ha at 13% humidity was obtained, and the Control was the treatment that provided the largest yield. The mean specific weight was 62.9 kg/hL. For Jallon hybrid barley, the average yield obtained was 4,037 kg/ha at 13% moisture, with an average specific weight of 52.5 kg/hL, and an average protein content of 14%.

For P0725 short cycle maize, the average yield in Castelló d'Empúries was 10,156 kg/ha at 14% humidity. There was an increase in the average value of the crop's nutritional status achieved for all the treatments as the crop developed. The values decline starting with the formation of the fruit, as the crop begins to dry out. The average percentage of plants with rot at the base of the stem was 6.7%, and the average percentage of broken plants was 5.9%. In the area of Torroella de Fluvià, the average yield of P0725 maize was 10,156 kg/ha at 14% humidity, and the average specific weight of P0725 short cycle wheat was 69 kg/hL.

The DKC6728 medium-long cycle maize tested in Castelló d'Empúries had an average yield of 14,329 kg/ha at 14% humidity, and an average specific weight of 64.8 kg/hL. No statistically significant differences were observed for most of the parameters evaluated before the maize harvest, except for the height of the cob node, which was higher (1.26 and 1.25 m) with treatment with a low dose (0+80 kg N/ha) and treatment with an overdose of nitrogen (170+80 kg N/ha).

#### Practical recommendations:

In organic production, the nitrogen contributions in the basic dressing fertiliser are very limited, and as such it is necessary to look for a fertilisation strategy to ensure the availability of nitrogen necessary for the proper development of the crop.

In general, the highest but moderate contributions of nitrogen fertiliser provide acceptable protein contents within the parameters required by the industry.

#### **Activity 5. Assessment of the agronomic viability of soy (*Glycine max*) cultivation in organic farming**

Significant differences in the height of the varieties tested and the insertion height of the first pod were observed between the varieties tested. There were significant differences in the greenness of the plants when the crop begins to dry out.

No significant differences in production were observed between the 10 soy varieties in different cycle types, or for the presence of disease at any of the sampling points.

A significant weed infestation problem was observed in the plots monitored, to the extent that the development of the crop was compromised.

#### Practical recommendations:

It is important to sow soy under the right conditions, which can ensure a good implantation of the crop. An efficient weeding strategy that does not compromise the crop must be sought.

#### **Activity 6. Transfer of the results**

The online technical seminars have had a considerable impact in the sector, with 90 attendees registering for the winter cereals seminar, and 80 registering for the summer cereals seminar. The field days were also successful, with 35 people attending the rapeseed seminar held on 16 April 2021, and 28 participants at the event held on 7 May, where the cultivation of barley was discussed. The digital seminar on rapeseed also had a strong impact, and the publications in the Extensiu.cat monthly newsletter transferred the results obtained to more than 800 people.

## Conclusions

The conclusions arising from the project for each activity are listed below:

### **Activity 1. Monitoring of organically cultivated plots belonging to farmers producing barley (*Hordeum vulgare*), maize (*Zea mays*) and alfalfa (*Medicago sativa*)**

1. Organic barley growers usually plant late, in December and January. The sowing density is generally higher than that used in conventional production.
2. All plots were sown with a cereal seed drill, with separation ranging from 12 to 15 cm, which makes it difficult to use hoes for weeding, and all the farmers who did their weeding mechanically did so using a harrow with flexible spikes.
3. Basic dressing fertilisers are usually important, and no farmer subsequently performs a cover dressing.
4. The yields from the different plots were relatively lower than anticipated the area under cultivation, although they were acceptable in most cases.
5. The quality of the grain in terms of moisture, hectolitre weight, protein content and starch varied widely between the plots. However, no mycotoxin contents that could affect the grain's acceptance were generally observed.
6. There was a trend to delay planting in the organically produced maize plots, from late May to late June in some cases. This was accompanied by the planting of a shorter cycle variety, which was usually a 500 cycle which enabled the harvest not to be delayed excessively.
7. The weeding strategies were very diverse, but an acceptable control of weeds was generally achieved.
8. The most frequently observed mycotoxins in the various plots were fumonisins, often with above acceptable values, and deoxynivalenol to a lesser extent.
9. In general, alfalfa adapted well in organic farming. One of the most important problems could be the quality of some of the harvests due to the significant presence of weeds.

### **Activity 2. Study of the agronomic feasibility of rapeseed cultivation in organic production systems**

10. Damage caused by aphids was significant during the early stages of crop development, compromising the viability of some plants. Although the effects were much greater in some areas, this pest was present in all the plots.



11. Sea barley is the major weed that generally affects all the plots. Initial levels of infestation were very high, and although efficiencies of 70% and 97% were achieved with mechanical weeding, the final density on the plot remained high.

According to the monitoring carried out on the rapeseed plots in the 2020-21 campaign, mechanical weeding with a thresher is approximately 15% more effective than using a harrow with flexible spikes.

12. It is important not to sow too late in order to be able to reach the recommended crop biomass at the end of winter and not to affect production.
13. The largest weevil populations were observed with *C. pallidactylus*, followed by *C. assimilis*. The latter had an average incidence of 7% of siliques leading to damage in the most severely affected plot.

### Activity 3. Assessment of new varieties of barley (*Hordeum vulgare*) and maize (*Zea mays*) in the organic production system

14. It is important to select barley varieties with characteristics that allow them to compete better with weeds, such as vegetation cover during the early stages of development and plant height. The RUBIANA, FATIMA, TRAVELER, LAGALIA and KWS FANTEX varieties presented the most soil coverage, while the ZOO, LG AUSTRAL, LG NABUCO, KWS FANTEX, JALLON and LAGALIA varieties presented the highest plants.
15. Because fungicides cannot be applied, it is necessary to sow varieties that are resistant to the main leaf diseases, and especially to the complex of brown spots which affects the crop to the greatest extent, and wheat leaf rust to a lesser extent. The JALLON, ZOO, FOCUS and MESETA varieties were the most resistant to brown spot, while only LG NABUCO, KWS FANTEX and RGT PLANET were more susceptible to wheat leaf rust, with severities above 5% of the leaf area affected. Spring varieties were generally observed to be most seriously affected by leaf diseases.
16. More vigorous plants are useful in the early stages of cultivation, in order to limit pest damage and to compete with weeds better. In the early stages of cultivation, no significant differences were observed in the vegetative development (biomass) of the plants of the different varieties. However, those with a 500 cycle had the highest values.
17. Problems with pests (borers, *Helicoverpa*, etc.), diseases (rot at the base of the stems) and accidents (broken plants) are usually more common in organic production. The most resistant plant material should therefore be used.
18. Differences in the height of the varieties may be a factor to take into account, especially in situations of high pressure from borers and climate conditions with strong winds.
19. Both trials showed that the 500 cycle varieties present a productive behaviour similar to that of longer cycle varieties.
20. A total of 9 different mycotoxins were analysed. The highest contents were detected in fumonisins.



**Activity 4. Impact of nitrogen fertilisation on the production, quality and health of barley (*Hordeum vulgare*) and maize (*Zea mays*)**

21. No significant differences in yield were observed between conventional barley varieties and the hybrid varieties used.
22. In the tests carried out in a plot with very fertile soil, providing a high dose of nitrogen does not generate a higher yield. In the four tests performed, the highest dose of N (210 kg N/ha in fractions of 140 kg N/ha in the basic dressing and 70 kg N/ha in the cover) did not reach the highest yield at any time. In some of the tests, providing the average dose of N (140 kg N/ha divided (70+70 kg N/ha)) can provide a higher yield than applying the same dose at one time (140+0 kg N/ha), before sowing the crop.
23. The high initial fertility of the plot in some cases leads to a reduced crop yield when fertiliser is applied.
24. The protein content of the grain in all four trials was highest in the treatment with the highest doses of nitrogen (140 + 70 kg N/ha), with statistically significant differences in some cases.
25. Higher starch content was observed in conventional barley varieties than in hybrid barley varieties. In general, no significant differences between fertilisation treatments were found.
26. Fertilisation influenced the effect of low temperature at times sensitive for cultivation on the proportion of aborted grains. The crop subject to treatments in which fertilisers were applied were affected to a lesser extent, with a lower proportion of aborted grains.
27. As for disease sensitivity, the conventional varieties were observed to be more sensitive to brown spot than the hybrid varieties.
28. Maize production levels in medium and long-cycle variety trials were higher than those in which short-cycle varieties have been used.
29. However, no differences in production for the various fertilisation treatments (including an unfertilised control) that were tested were observed in any of the trials.
30. The soil was very fertile in both plots, especially in the area where a long-cycle variety of maize was planted. The lower but nevertheless high fertility of the plot where only a short-cycle variety was planted was probably offset by the crop's lower nutrient requirements, due to lower production levels achieved.

**Activity 5. Assessment of the agronomic viability of soy (*Glycine max*) cultivation in organic farming**

31. Although soy is a crop that can be adapted to the organic production system, there are several problems that can affect the success of its cultivation, including the implementation and control of grasses.

**Activity 6. Transfer of the results**

32. The extensive dissemination of the results obtained during the project has had a significant impact and positive acceptance within the sector.

**Leader of the Operational Group**

ORGANISATION: NUTREX PINSOS, SL

**Coordinator of the Operational Group**

ORGANISATION: NUTREX PINSOS, SL

**Other members of the Operational Group (grant recipients)**

ORGANISATION: AGRO ASSA FOODS S.A.

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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):**

Girona, Barcelona, Tarragona and Lleida

**REGION(S):**

El Pla de l'Estany, El Ripollès, El Vallès Oriental, La Garrotxa and El Segrià

## Dissemination of the project: publications, seminars, multimedia, etc. (State

A series of dissemination activities have been carried out in order to raise the profile of the project and the results obtained:

- **Technical webinar 2020: Organic winter cereal production.**
- **Technical webinar 2021: Organic maize and soy production.**  
Seminar video link: [Organic maize and soy production seminar - YouTube](#)
- **Field event: Organically produced rapeseed.**
- **Field event: Organically produced barley.**
- **Digital seminar on rapeseed.**
- **Technical webinar 2021: RECOMEX Test results and innovations in winter cereals.**
- **Articles published in the Extensius.cat monthly newsletter**

The following three articles related to the results obtained in rapeseed cultivation have been published in the section on pests and diseases:

- 'El saltiró de la colza, una amenaça per la bona implantació del cultiu' (26 November 2020), <http://extensius.cat/2020/11/26/el-saltiro-de-la-colza-una-amenaca-per-la-bona-implantacio-del-cultiu/>
- 'Les larves del saltiró de la colza' (27 January 2021), <http://extensius.cat/2021/01/27/les-larves-del-saltiro-de-la-colza/>
- 'lagues que afecten la colza abans de la floració' (29 March 2021), <http://extensius.cat/2021/03/29/plagues-que-afecten-a-la-colza-abans-de-la-floracio/>

## More information on the project

PROJECT DATES	TOTAL BUDGET
Starting date: July 2019	Total budget: €181,714.29
End date: September 2021	DARP funding: €74,262.85
Current status: Executed	EU funding: €56,022.86
	Own funding: €51,428.58

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