

## New scenarios for the industrial production of aromatic and medicinal plants in traditional agricultural systems in Catalonia

### Summary

The project aims to analyse the performance of different commercial varieties of a set of aromatic and medicinal plant (AMP) species that could be grown commercially in different agricultural scenarios in Catalonia.

Species have been chosen which are in good demand on the market both as dried plant and essential oil and which can be adapted to different growing conditions.

During this period of work, information has been collected on crop management, including mechanisation, especially weed control and harvesting, and on industrial processing systems (drying and distillation) to help plan a real large-scale cultivation strategy.

At the same time, it has also been observed whether this type of crop has an impact on pollinating insect populations, on the biodiversity of the agricultural system and whether it can be compatible for cultivation in steppe bird protection areas (SPAs).

### Objectives

1. To assess the agronomic response, quality (chemical composition), cultural and mechanisation requirements of large-scale cultivation of some aromatic and medicinal plant (AMP) species in order to consider an integrated production scale within current cropping systems.
2. To obtain a real and contrasted analysis of the economic and technical viability of the production on an industrial scale of some AMP species introduced as possible crops in agricultural systems in Catalonia.
3. To observe the compatibility of the cultural management applied to these crops with the conservation of steppe bird species in the agricultural areas declared as SPAs in order to be able to include the cultivation of AMP as a possible productive alternative in the SPAs.
4. To assess the impact of these crops on biodiversity by measuring their function as an enhancer and maintainer of pollinating insect populations in the plantations themselves and in adjacent agricultural areas.

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

During the two years of the project, the actions carried out fall into three main groups:

#### **Agricultural, technological, environmental and market observation and research activities:**

- Mainly the establishment of three test plots in Castellans (Garrigues), Preixens (Noguera) and Sanaüja (Segarra) and the monitoring and sampling of the different species. Experiments were carried out under different irrigation conditions: Sanaüja unirrigated, Castellans and Preixens irrigated and with 10 different botanical species (*Artemisia absinthium*, *Melissa officinalis*, *Mentha x piperita*, *Mentha spicata*, *Lavandula angustifolia*, *Lavandula x intermedia*, *Satureja montana*, *Thymus mantichina*, *Thymus citriodorus* and *Matricaria recutita*) and some commercial varieties or different origins for some of them.
- During the spring of 2020 Riera lavandin and *Thymus citriodorus* were planted in the three plots but due to problems with the herbicides and a plague of rabbits in the Preixens plot, the operation had to be repeated during the spring of 2021, changing the herbicide and putting up a protective fence in Preixens. In 2021 all the species were well established in the three plots and the monitoring of these plantations in the 2021 and 2022 campaigns has allowed us to know the agronomic response, yield and quality of the final product obtained (essential oil and dry grass) of the different species, to contrast the possibilities of cultural management, especially weed control using machinery or herbicides, and to identify some

phytosanitary problems. Great care has been taken in the use of some localised herbicides and results have been obtained (<https://pamincat.ctfc.cat/resultats/>).

- Evaluation of the abundance of pollinating insects in the AMP plots of Castellans and Sanaüja at the time of flowering of lavender in contrast with neighbouring plots of cereals, almond trees and fallow land. Trapping during these two years has allowed us to quantitatively assess the abundance of the main families of pollinators present in this type of crop and to calculate the Shannon index (indicator of the biodiversity of a site). On the other hand, knowing the port of each plant, the soil cover, the phenological stages throughout the growing season, the most appropriate cultural management for each species and the time to carry it out and specifically the time (or times) of mowing has helped us to make a first approximation of the compatibility of this type of crop with the management restrictions defined in the SPAs.
- Organoleptic analysis of dried herb samples obtained during the 2021 campaign carried out by the main herb wholesalers in Spain and quality analysis of the essential oils carried out by Ventós, a non-beneficiary project partner.
- Market analysis identifying the volumes consumed of the species tested, both dry herb and essential oil, both at world and Spanish level, and identifying and describing the commercial circuit for these two products, focusing on the industrial consumer level of large volumes of commercial product as possible clients for a future production project.
- Prospecting for large-scale industrial distillation and drying systems capable of processing the volume of fresh plant generated in a simulated industrial production scenario. In the last year of the project, information was obtained from commercial and industrial engineers about the possible transformation systems and the dimensioning of the installations that best fitted the future needs.

#### Training activities

- Technical meetings and workshops with AMP producers in order to give the members of the task force first-hand knowledge of AMP production (cultivation and processing) to get an idea of the infrastructure and equipment needs and also to compare investment and production costs.

Throughout the project, therefore, meetings have been held with well-established primary sector actors, most of them with mature projects, in order to exchange doubts, concerns and uncertainties. Five visits or technical itineraries were carried out, which allowed us to visit 12 different production projects, mainly oriented towards the wholesale production of essential oil and located in the communities of Castile-La Mancha, Aragon and Valencia, and dry grass production in Catalonia, as well as a visit to a small producer who complements production with recreational and educational activities.

#### Outreach activities:

- 3 PATT congresses.
- 2 working days with other producers.
- 7 cultivation sheets.
- Development of a virtual tool “Cost-PAM” (<https://cost-pam.ctfc.cat/>) that will help to understand economic aspects of the crop in simulated production scenarios. The choice of content and the definition of the fields, the design of the route, the graphic design, the mechanics of the calculation engine, etc. have been aspects to be defined and the subject of many tests for the creation and adjustment of the tool. Finally, a useful tool has been obtained that is fairly faithful to the different production scenarios proposed and will give fairly accurate results. All this material will be accessible through the project’s own website and through the websites of each of the partners that redirect to the project’s website.
- 3 publications (*Fitoterapia*, *Agricultura* and *Ruralcat*) dissemination (already committed but still to be carried out pending a more detailed analysis of the field results obtained in these two campaigns).

## Final results and practical recommendations

The final results are as follows:

Firstly, the insufficient length of the trial, given that only the first two years of the production cycle have been covered, when for most of these species the full cycle can be 8-10 years, limits the conclusions and weakens the reliability of the projections that can be made.

### Culture results:

- In a rain-fed area with an annual rainfall of 250-300 mm (Sanaüja plot) AMP could not be grown for two consecutive years. The extreme conditions of continuous drought over the last two years have cancelled out any trial results. However, plants that have survived and developed under these conditions would be very good material to start selection and breeding work.

- ***Melissa officinalis*** (lemon balm) is a very good crop in all irrigation zones and needs a guaranteed minimum of 650 mm of water during the growing season (April to October), which means that a stand irrigation is sufficient. Drip irrigation works, although after planting only 1 drip tube between the two rows is not enough and 2-3 localised support irrigations have to be made near the seedling tray cells.

This plant is very combative with weeds and withstands mechanical maintenance between rows (either with a cultivator or a weed cutter). With a planting density of 21,111 plants/ha, a double row design (row spacing 1.8 m and row spacing 0.45 m) and plants spaced 0.40 m apart within the row, once the plant has matured, from the first year onwards, it can form a continuous, thick hedge covering 80% of the entire plot.

Lemon balm is resistant to napropamide applied early in the season when the plant is still dormant and, if the field is clean, controls weeds well. Three cuts can be made during the season, May, June and September, the least abundant being the summer cut, but up to four could be made in a commercial crop harvested at the appropriate times.

It has been found to be sensitive to high levels of calcium carbonate equivalent showing symptoms of iron chlorosis.

The three varieties tested gave very good yields and quality, with the Lemona variety being the least productive.

- ***Mentha piperita*** and ***Mentha spicata*** responded well, although their development has been limited by the drip irrigation used as it does not cover all the soil surface that can be covered by the growth of the rhizomes. A planting density of 21,111 plants/ha with the same planting frames as for lemon balm is adequate, since in the second season the two rows, initially 40-45 cm apart, have come to form a hedge of 120 cm, especially *Mentha piperita*. The water requirements of these species are higher and about 900 mm should be applied from May to October, and they are observed to be very greedy for water and respond with higher biomass production above this. Here too, three cuts have been made, but this could be increased to four if the periods between cuts were shortened.

*Mentha spicata* has a shorter vegetative period than *Mentha piperita* and flowers earlier, therefore it is more demanding when cutting. It is less productive and more susceptible to symptoms of bud rot or deficiencies.

These species do not adapt to plastic mulch or anti-germination netting as it severely restricts their growth.

No diseases or pests have been seen except for one episode of rust on *Mentha spicata*.

- ***Thymus citriodorus*** was planted in 2021 on rain-fed (Sanaüja) and irrigated (Preixens) plots. In the first case there were very high losses due to the lack of rainfall and it was not replanted and on irrigated land (Preixens), despite obtaining a good response during the first season, it was discarded in the second year as it is a species that is of no interest to the market.
- ***Thymus mastichina*** was very productive under irrigation with 8 and 5 t/ha depending on the varieties or the origins of the biomass and with a concentration of 18% in essential oil. In rain-fed crops, although it remained in the field, it suffered greatly from the water stress situations of these two seasons (2021-2022) and its yield was negligible. The German variety had the lowest yield, with the seeds from Semillas

Cantueso giving the most productive plant. The market price of this species and the yield of essential oil make it interesting for commercial cultivation.

- ***Lavanda x intermedia* and *Lavanda angustifolia***. In dry conditions (less than 400 mm in 2021 and 2022) this crop cannot be considered as we have seen how in the Sanaüja plot at the end of the winter of 2022 the lavandins planted in 2020 were on the point of dying and a rainfall in April revived them. The planting frame for all of them was 1.8 m between rows and 0.5 m inside the row and was adequate, although it could have been 0.45 m.

In general, Grosso lavandin has had yields between 7.5 and 5.2 t fresh plant/ha under irrigation, with the one planted in cells being more productive this first season than the one planted with bare root. In rain-fed crops, yields were 0.69 and 1.12 t fresh plant/ha. The essential oil concentration of the fresh plant is around 15-16%. The selec. riera lavandins planted in 2020, which already had a commercial cutting in 2021 yielded 11.4 t fresh plant/ha on irrigated land and 3.8 t/ha on rain-fed land and an average oil concentration of 8%. Now, the Castellidans plants have been affected by pests or disease and have begun to see some losses after the cutting of this second campaign.

The first year of *Lavandula angustifolia* was very good, especially in Castellidans with a soil with a very high level of calcium carbonate equivalent with a yield of 13.4 t fresh plant/ha, 3.2 t fresh plant/ha in Preixens and 1.0 fresh plant/ha in Sanaüja with an essential oil concentration of 9%.

- ***Satureja montana*** responded very well under irrigation with yields of 17.2 and 13.8 t fresh plant/ha with the plant from wild seeds being more productive than the German one. The essential oil concentration of this fresh plant has been around 4%, differing between varieties or origin of the plant material.
- In a rain-fed area with 400 mm annual rainfall, the yield would probably have been quite good, but the lack of homogeneity in the frequency of rainfall makes it very vulnerable.
- ***Artemisia absinthium*** (wormwood) is a very good species for rain-fed cultivation as it has survived and vegetated acceptably, but a minimum of 400 mm per year is necessary to consider it as a crop. In irrigated conditions it has given a very good response and has been seen as an option to consider if the market stabilises its demand. Yields of 24 t/ha of fresh plant obtained under irrigation compared to 12.4 t/ha under very restrictive drought conditions.
- ***Matricaria recutita*** (chamomile) at 8 kg/ha has given a yield of 30 t/ha the first cut and 6.4 t/ha the second cut with a water input of 254 l/m<sup>2</sup> during the 106 days of cultivation (86 days the first cut and another 20 days the second cut).

#### Environmental results:

- With regard to the population of pollinating insects, the AMP plots in both Sanaüja and Castellidans have shown higher values of richness and abundance of pollinating insects than the surrounding farms.
- The high Shannon index values for the farms as a whole suggest that a mosaic landscape, with the incorporation of aromatic and medicinal plant plots, is an excellent management typology for these steppe environments, where biodiversity and the relationships between the different functional groups of fauna, from invertebrate species to vertebrates at the highest levels of the food web, are increased.
- As for the compatibility of AMP cultivation in SPAs, despite the lack of references, the analysis carried out in the framework of PAMinCAT seems to indicate that AMP crops may be potentially usable habitats for some steppe bird species. It may be necessary to adjust and assess some cultural treatments, as well as to plan AMP species to be introduced, depending on the potential impact on birds in the area. Furthermore, from the perspective of biodiversity conservation, and of steppe birds in particular, it is necessary to see AMP crops as a potential option to increase heterogeneity of the agricultural landscape in a context of crop and lava diversification in already homogeneous areas, while maintaining the traditional dominant matrix of cereal crops and fallow land (key for spices and not substitutable by crops).

#### Outreach outcomes (outputs and actions):

- Production of 7 crop data sheets

- Creation of a decision tool: “Cost-PAM” (<https://cost-pam.ctfc.cat/>) designed and produced in the framework of the PAMinCAT project. This tool aims to simulate production scenarios for different AMP species and to obtain an approximate economic balance.
- 3 PATT congresses were held.

#### Recommendations:

- Although they are very undemanding crops in terms of irrigation, the extreme dry conditions of these two growing seasons have been disastrous for all the Labiatae (lavenders, lavandins, thyme and savory) and in Sanaüja the two-year-old lavandins have suffered a lot. At the end of the second winter they seemed to have died, but after a heavy rain in April 2022 they were revived. Rainfall of more than 400 mm is necessary for rain-fed cultivation.
- **Artemisia absinthium** flowered in the year after planting and has survived the drought without any damage and has given an acceptable yield. A very good crop is on the horizon if there is market demand.
- The allelopathic effect of wormwood and savory should be studied as an absence of weeds has been observed in the field within the double rows and in the surrounding area.
- **Matricaria recutita** origin “Linyola” has not germinated in any year. The German seeds had an excellent response. This species is very sensitive to sowing depth and sowing depth must be very shallow.
- It is not advisable to water **mints** by drip irrigation, but if it is necessary to do so, several tubes should be used to accompany and cover the surface area occupied by the plant for the development of its rhizomes, especially *Mentha x piperita*. An initial surface area of 50 cm ends up taking up 120 cm after one year. *Mentha spicata* does not spread so much on the surface and seems a priori to need more water. It has a shorter vegetative cycle and needs to be cut more often.
- The mulching in the first year was positive for savory, mastic thyme and lemon balm, but not for spearmint or piperita as it severely limited their growth. Peppermint quickly covered the soil with its rhizomes.
- It should be tested whether sprinkler irrigation in the case of mint and lemon balm is better than localised drip irrigation.
- Drip irrigation is not suitable in the first year when the plants are planted in double rows because the water does not reach the seedling cells of the plants and very large quantities of water have to be supplied.
- A two-line processing centre (distillation and drying) or one that covers the processing by distillation of three to four species at different times in the production season can be envisaged. A distillery processing 3-4 ha of crops per day could cover 60 ha of lavender/lavandin, 20-30 ha of thyme, 20-30 ha of savory and 20-30 ha of wormwood as their flowering is staggered during the growing season. In parallel, the production of lemon balm and peppermint, which are easy to handle and have good yields, could also be considered, to be transformed in a drying process to obtain dried plants. About 20-25 ha between the two is a good size. Thus, an initial cultivation area of 200-250 hectares combining the production of essential oil and dried herb with thyme, spike lavender, savory and wormwood for essential oil and peppermint and lemon balm for dried plants has been defined as the minimum area for processing facilities to serve them. This area should be located 30-40 km away from the distillery and 10-15 km from the dryer in order not to reduce the quality of the harvested grass to be processed.
- Minimum cultivation unit of 3-4 ha for plants intended for the production of essential oils (daily working capacity of a 1-thread harvester). Minimum cultivation unit of 1 ha for the production of herbaceous leaf species to be dried.

## Conclusions

The idea of cultivation in strict drylands (below 400 mm) has to be discarded, as even the most resistant botanical species do not offer viable biomass yields that can be sustained for several years.

- Most species are suitable for localised irrigation.

- A processing centre serving production areas is indispensable.
- It is necessary to consolidate the marketing of the final product (essential oil or dried plant) with consumer companies.
- Increasingly, mechanical weed control combined with permanent cover crop management is becoming the norm.
- The cultivation of wormwood has been seen to have good potential and, moreover, with applications in organic farming due to its allelopathic properties.

### Leader of the Operational Group

ORGANISATION: FRUITS DE PONENT, SCCL

### Coordinator of the Operational Group

ORGANISATION: Forest Sciences and Technology Centre of Catalonia (CTFC)

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

ORGANISATION: Aigües Segarra-Garrigues S.A.

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

ORGANISATION: Laboratory VIENTOS

ORGANISATION: Forestry Technology Centre of Catalonia

### Geographical area(s) of application

| PROVINCE(S)  | REGION(S)   |
|--|---|
| <p>The project has been implemented in three plots located in the province of Lleida.</p> <p>However, the territorial scope of application of the results could be extended to other provinces as long as they have more or less guaranteed water.</p> | <p>Initially, work has been carried out in the Garrigues, Noguera and Segarra regions. Although the cultivation of AMP could be extended to other regions such as Pallars Jussà, Alt Urgell, Solsonès, Bages, Cuenca de Barberà, Urgell, Pla d'Urgell and Segrià as long as a regular water supply is guaranteed.</p> |

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

#### PATT Congresses

[Is the cultivation of aromatic and medicinal plants possible in SPAs?](#)

7 July 2022 in Tàrraga.

More than 30 attendees, mostly from the area.

With the presentation of the project **PAMinCAT** by Roser Cristóbal from CTFC and the presentation of the restrictions on crops in SPA areas by Xavi Petit from Aigües del Segarra-Garrigues on the Preixens plot and later, at the Tàrraga school, presentations by Gerard Bota from CTFC and Javier Ruiz from the Global Nature Foundation. Jordi Puig from the Espigall consultancy was unable to attend and made his intervention on-line at the end of July.

The final assessment of the participants was very positive.

#### [Economic viability of cultivation of aromatic and medicinal plants](#)

27 September 2022 at Alcarràs

21 attendees

Presentation of three different consolidated production projects "Fundación Tervalis" (Teruel), "Aromáticas del Piedra" (Guadalajara) and "L'Armengol" (Catalonia) the first two to produce essential oils and the last one dried plants, explaining mainly and generally an economic balance of the activity throughout its productive process.



In addition, Roser Cristóbal from CTFC presented the economic balance of lavender production for the production of essential oils and, taking advantage of the presence of consolidated AMP producers, it was possible to validate aspects of costs, investments and income from the same crops.

Another presentation was the decision tool: “**Cost-PAM**” (<https://cost-pam.ctfc.cat/>) designed and produced in the framework of the PAMinCAT project which aims to simulate production scenarios of different species of AMP, and through a calculation engine, to provide an economic balance of that assumed scenario.

A third PATT congress is planned for early November to present all the final results of the PAMinCAT project.

### Presentation of the project

In addition to the PATT congresses, the project was presented at two seminars within the framework of the FoRUo project. A first day on 10 March 2022 was a working day and visit with producers in the northern part of Guadalajara and a second presentation on 12 April 2022 on the final day of the FoRUo project.

Specifically, during the visit to Tortuera, attendees saw plantations, machinery, a distillery and a project for the management of ecological lavender plantations in an area adjacent to an SPA for the protection of Dupont’s lark. In this case, the explanations of the technician regarding the project approach and the results obtained were of great interest to the members of the OG due to the similarity in the SPAs of the Segarra-Garrigues canal.

On 12 April 2022, on the final day of the FoRUo project, which was attended by all the project partners and other interested parties, there was also a presentation of the PAMinCAT project and a visit to the dryland plot in Sanaüja and the irrigated plot in Preixens.

### Multimedia

- Creation of the project’s own website: <https://pamincat.ctfc.cat/>
- Partners’ websites: since the launch of the project, a summary of the project has been published on the websites of the three partners with a link to the project website: <https://www.fruitsponent.com/ca/node/2164>, <http://www.aiguessegarragarriques.cat/ca/>, <https://www.ventos.com/ca/projectes/pam-in-cat>, <https://ctfc.cat/projectes.php>

In addition to appearing on the partners’ websites, on the CTFC’s own social networks (Facebook, YouTube, CTFC Blog, ...) and those of the other partners, sporadic news has also appeared throughout the months the project was under way. In addition, entries have also been made in the INFOPAM Blog. The different inputs:

### INSTAGRAM

#### infopam\_ctfc

[https://www.instagram.com/p/CikrS3-tt9T/?next=%2Finfopam\\_ctfc%2F](https://www.instagram.com/p/CikrS3-tt9T/?next=%2Finfopam_ctfc%2F). 18 likes, 4 comments

[https://www.instagram.com/p/CewTTHRth5F/?next=%2Finfopam\\_ctfc%2F](https://www.instagram.com/p/CewTTHRth5F/?next=%2Finfopam_ctfc%2F). 50 likes, 6 comments

[https://www.instagram.com/p/COW2vlyNeY7/?next=%2Finfopam\\_ctfc%2F](https://www.instagram.com/p/COW2vlyNeY7/?next=%2Finfopam_ctfc%2F). 13 likes

<https://www.instagram.com/p/CNsDfrHocn4/>. 142 views, 4 comments

[https://www.instagram.com/p/CNp\\_wzrBUfh/](https://www.instagram.com/p/CNp_wzrBUfh/). 31 likes, 2 comments

<https://www.instagram.com/p/CNm8JNihONf/>. 41 likes

#### Fruitsdeponent

[https://www.instagram.com/p/CftFi\\_DNu\\_E/?next=%2Finfopam\\_ctfc%2F](https://www.instagram.com/p/CftFi_DNu_E/?next=%2Finfopam_ctfc%2F). 27 likes

#### Aiguessegarragarriques

<https://www.instagram.com/p/Ch6uP8Stfbk/>. 7 likes

<https://www.instagram.com/p/Cfb3XesK-IV/>. 5 likes

### YouTube

<https://www.youtube.com/watch?v=ZU5ku1lmtMM>. 139 views

<https://www.youtube.com/watch?v=EUJ7KWO4vjY>. 39 views

<https://www.youtube.com/watch?v=EEwsslbh-5U&t=2s>. 46 views

<https://www.youtube.com/watch?v=bTPA7nleOoA&t=4s>. 7 views

<https://www.youtube.com/watch?v=rX-gRju5tYg>. 16 views

### FACEBOOK

**Informational publications**

As we do not have all the results of the project, they have yet to be published. However, we have a commitment from the magazine *Fitoterapia* (CITA Publicaciones y Documentación) aimed at the AMP consumer sector and the producer of final products mainly in the field of health and from *Agricultura* (Editorial Agrícola) aimed at the agricultural sector and of national scope to publish two informative articles for us by the end of the year.

In addition, we will also use RuralCat as a dissemination channel with a news item and a technical article to appear in the last four months of 2022 or early 2023.

**Attendance at sectoral fairs or congresses**

Due to the global social situation of the last two years and the adaptations and restrictions on mobility and work that we have all had to endure, it has not been possible to visit any fairs or congresses.

**Project website**

<https://pamincat.ctfc.cat/>  
<https://pamincat.ctfc.cat/resultats/>

**More information on the project**

| PROJECT DATES                                | TOTAL BUDGET              |
|--|---------------------------|
| Start date (month-year): July 2020           | Total budget: €128,963.30 |
| Completion date (month-year): September 2022 | DACC funding: €68,350.55  |
| Current status: Completed                    | EU funding: €60,612.75    |
|  | Own funding: €50,906.70   |

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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.*

