EIP-AGRI Focus Group

Plant-based medicinal and cosmetic products

FINAL REPORT
JULY 2020

funded by European Commission

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1. Executive summary

During 2019, the **EIP-AGRI Focus Group on Plant-based Medicinal and Cosmetic Products** has analysed the key factors that influence farmers and foresters to enter the Medicinal and Aromatic Plant (MAP) sector. The main question was: *'How to create diversification opportunities for farmers through innovative value chains of plant-based medicinal and cosmetic products?'*

For the purpose of the Focus Group, a **'Plant-based medicinal and cosmetic product'** is defined as raw or semi-processed plant material (e.g. dried herb, essential oil, plant extract) that can be obtained by a producer (i.e. grower or wild collector) and used for manufacturing various plant-based products such as herbal medicines, cosmetics, supplements and functional food.

In summary, MAPs contribute to **integrated agro-industrial pathways** through providing plant raw materials and intermediate products which have significant economic value to different industrial sectors beyond agriculture. Apart from **technological innovations**, there is a need to create opportunities for diversification in rural areas through **sustainable social innovations,** e.g. to increase the territorial capital through diversification of landscapes, preservation of biodiversity, cross-sectoral and territorial integration and combinations with other sectors like bio-economy activities and agro-tourism. In this regard, MAPs may be considered as a valid tool for multifunctional development of agricultural activity. The Mediterranean basin, for instance, is characterised as the epicentre of economic diversification and sustainable development, e.g. exploitation of low input agricultural productive systems, medicinal agroforestry, bio-economy and agro-touristic activities. In response to the ongoing challenges, farmers and foresters must adopt or create **new business models**, adapted to the regional MAP production systems. Furthermore, the Focus Group experts emphasised the need to increase the possibilities for women, young people and local people to participate in innovative processes involving the MAP value chain. The Focus Group identified new ideas for potential **Operational Groups and other innovative projects**, covering a full-spectrum of innovative solutions in the MAP sector and which can be implemented all over Europe. Also, they identified **research needs from practice** and possible gaps in technical knowledge, specifically working on themes around domestication and cultivation, conservation and sustainable use of wild resources, postharvest technologies, drying and extraction, product development, access to markets, logistics and distribution, multi-functionality management and benefits of MAPs to other ecosystem services.

Figure 1: Focus Group Experts Medicinal plants at the October meeting 2019 in Cholet, France

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2. Introduction

The need for plant materials intended for cosmetic and medicinal purposes, combined with the need to protect plant biodiversity, creates an opportunity for farmers and foresters to diversify their production and improve their income. However, the competitiveness and sustainability of the value chains working with newly cultivated or wild managed plants used for medicinal and cosmetic products is often under pressure. The Medicinal and Aromatic Plant (MAP) sector is undergoing changes, and societal drivers such as digitalisation and environmental changes – especially climate change – create both risks and opportunities.

This report summarises the comprehensive work carried out by the **EIP-AGRI Focus Group on Plant-based Medicinal and Cosmetic Products** (**Annex I**), which brought together 20 experts with complementary types of knowledge from 15 European countries, offering a wide range of expertise in terms of multidisciplinarity and geographic diversity. The Focus Group linked researchers and advisers with herb growers, practitioners and other stakeholders knowledgeable about the MAP sector. A starting paper (Argyropoulos, 2019)[1] was circulated to the experts prior to the first meeting in Setubal, Portugal. This served as a starting point for the discussions during the first meeting.

The main question addressed by the Focus Group was: '**How to create diversification opportunities for farmers through innovative value chains of plant-based medicinal and cosmetic products?'**

Definition: A '**Plant-based medicinal and cosmetic product'** is defined as a raw or semi-processed plant material (e.g. dried herb, essential oil, plant extract) that can be obtained by a producer (i.e. grower or wild collector) and used for manufacturing various plant-based products such as herbal medicines, cosmetics, supplements and functional food.

A number of key topics were discussed in eight mini-papers, which represent the building blocks of this report: **MP1** Main actors, markets and collaboration of MAP value chain; **MP2** Business models and empowerment of farmers/collectors in the value chain; **MP3** Benefits of MAPs for farming/forest systems: multi-functionality, ecosystem services and social benefits; **MP4** Plant raw materials for herbal medicinal products, botanical food supplements and frontier products: requirements for quality, safety and efficacy; **MP5** Wild collection: recommendations to avoid over exploitation and to promote sustainable use of wild resources; **MP6** Technical needs in the primary sector (propagation, cultivation, harvesting and weed management); **MP7** Postharvest handling and drying of MAPs; **MP8** Knowledge exchange, flows, training needs and tools.

[1] https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/fg35_starting_paper_2019_en.pdf

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3. State of play

MAP production data, challenges and opportunities

In the last decades, the rising concern about potentially harmful synthetic additives (both because of reported side effects and due to economic worries), resulted in a reallocation of consumer preferences to the use of natural resources as functional ingredients for products in pharmaceutical, food & beverage, cosmetic and agrochemical industries. This included a shift toward the use of **Medicinal and Aromatic Plants (MAPs)**, their extracts and essential oils. Nowadays, there is an expanding interest in **plant-based extracts** where end-use industries are looking for efficacious, safe and cost-effective natural bio-actives with clearly defined modes of action and proven benefits. The global market for botanicals continues to grow and was valued at $108 billion in 2015, with **herbal medicines** making up 48%of that, **cosmetics** 17% and **supplements & functional food** 35%[2].

Apart from the traditional market segments, the rapidly growing market of supplements and functional food in Europe creates significant opportunities for key actors in the value chain, i.e., farmers, local collectors, resource managers, processors and distributors.

Europe has a long tradition in collecting wild plant resources. Uncounted MAP species are used in the cosmetic and botanical industries and the great majority of these materials is provided by collecting MAPs from natural habitats. Greece, for instance, is home to more than 6,600 herbs, many of which (approximately 1,400) are indigenous. Although collection of MAPs from wild resources is a common practice, it often reduces the natural population's size, resulting in highly heterogenous raw material due to the existing genetic and chemical diversity[3]. Given their positive impacts on local economies and higher value to local collectors, sustainable collection is often considered the most important conservation strategy for wild plant species[4]. **MP5** provides recommendations on how to promote the sustainable use and avoid the overexploitation of wild resources. On this point, the **Nagoya Protocol of the Convention on Biological Diversity**[5] creates greater legal certainty and transparency for both providers and users of genetic resources.

An enhanced production and **steady supply of plant raw materials** in Europe can be guaranteed under controlled conditions by field or greenhouse cultivation of MAPs **(MP6)**. In some cases this may contribute to conservation of threatened medicinal plant species, especially when these are considered high added-value products. However, it is not easy to precisely assess how many MAPs are commercially traded on an international or even national level. Also, the vast majority of the trade worldwide is based on dried plant material.

In Europe, MAPs are cultivated on an area exceeding 200,000 ha, most of which is located in France (52,000 ha), Poland (30,000 ha), Spain (27,800 ha), Bulgaria (16,800 ha), Germany (13,000 ha), Croatia (8,500 ha), Czech Republic (7,225 ha), Italy (7,191 ha), Greece (6,800 ha) and Austria (4,136 ha). Some important MAPs (indicative only) in terms of economic value, end-use and demand from industry are shown below:

Common name	Species	Part of plant used
Chamomile	*Matricaria chamomilla* L.	Flower
Peppermint	*Mentha x piperita* L.	Leaf
Valerian	*Valeriana officinalis* L.	Root
Fennel	*Foeniculum vulgare Mill.*	Seed
Saffron	*Crocus sativus* L.	Stigma

[2] https://dechema.de/dechema_media/Downloads/Positionspapiere/Position+Paper+Phytoextracts+2017-p-20002740.pdf
[3] Govindaraghavan S & Sucher NJ, 2015. Quality assessment of medicinal herbs and their extracts: Criteria and prerequisites for consistent safety and efficacy of herbal medicines. Epilepsy & Behavior 52, 363-371.
[4] Schippmann U, Leaman D, Cunningham AB, 2006. A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects. In: Bogers RJ, Craker LE, Lange D (Eds), Medicinal and aromatic plants - agricultural, commercial, ecological, legal, pharmacological and social aspects. Springer, Berlin, pp. 75-95.
[5] https://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf

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Indeed, domestic cultivation of MAPs in Europe is still very small compared to other crops. The fact that the majority of dried plant material is wild-harvested and/or imported from outside the EU, appears a good opportunity to **intensify the sustainable production and processing of MAPs** in Europe.

From the marketing perspective, **domestication and cultivation of MAPs** offer unique new opportunities, such as an increase in authentic and botanically reliable products; a guaranteed steady source of raw material; better rapport between growers and wholesalers; controlled postharvest handling and therefore rigorous quality control; possibilities for adjustments of product standards to regulations and consumer preferences; and product certification[6].

Many farmers, in turn may consider **MAP cultivation as more profitable than traditional crops**. However, farmers and foresters must adopt or create new business models, adapted to the regional MAP production systems. **MP2** gives an insight into business models and the empowerment of farmers/wild collectors in the MAP value chain.

Requirements for **sustainability in wild-collection and cultivation of MAPs** from the side of consumers and regulatory bodies are increasing. The actors in the value chain should address consumers' expectations, e.g. raw material sourcing, product innovation, traceability, quality regulation, efficacy and safety **(MP4),** while also considering sustainability in different contexts, e.g. environmental, social and economic and transparency throughout the supply (value) chain. MAPs may be regarded as industrial crops, since their products can be used in different industrial sectors beyond agriculture, such as in pharmaceutical or flavour and fragrance industries. With the increasing demand for these plants and their value-added products, a number of **business opportunities** may arise that can contribute to the sustainable development of resource-efficient and economically profitable crops in rural areas of Europe. This approach can help to increase farmers' incomes through access to new markets, as well as increasing the value of marginal land.

Figure 2 Fields of sage in Italy (source: Cogliandro, Aboca)

[6] Pierce AR & Laird SA, 2003. In search of comprehensive standards for non-timber forest products in the botanicals trade. International Forestry Review 5, 138-147.

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MAP value chain

MAP-derived natural products, either as pure compounds or as standardised plant extracts, provide numerous opportunities for novel applications.

There are four types of plant materials according to the degree of processing, preparation and transformation:

- **Fresh plant material:** whole, cut or specific parts of fresh and cleaned plant raw material
- **Dried plant material:** whole, or selected parts of MAPs
- **Essential oil:** product derived from the distillation of MAPs
- **Plant extract:** product derived from dissolution and extraction of the active ingredients

The **MAP sector** is a **long agro-industrial sector producing 'intermediate products'.** The value chain of MAPs encompasses all production/collection and processing steps to produce plant-based medicinal and cosmetic products: selection of plant raw materials, cultivation and/or wild-harvest, postharvest handling (drying and dry herb processing), distillation or extraction, purification (and/or isolation), product formulation and packaging. It usually consists of a set of interdependent enterprises with complementary activities (e.g. production, processing, trading and end-use industry).

The **core actors in the MAP value chain** (MP1) typically include input suppliers, farm machinery manufacturers or technology providers, primary producers (wild-collectors or herb growers), primary and secondary processors (drying and extraction), wholesalers (agents or traders), service providers (quality assurance, certification) and end-use industries.

The process steps of raw material sourcing, postharvest handling and drying are performed by herb growers/local wild collectors or processors – individually or in a cooperative.

Figure 3 shows the value chain of medicinal and aromatic plants from the raw material to a final formulated product. In order to ensure appropriate and consistent quality of herbal substances via active ingredient purification, high quality requirements, such as **Good Agricultural and Collection Practice (GACP)** and **Good Manufacturing Practice (GMP)** need to be fulfilled.

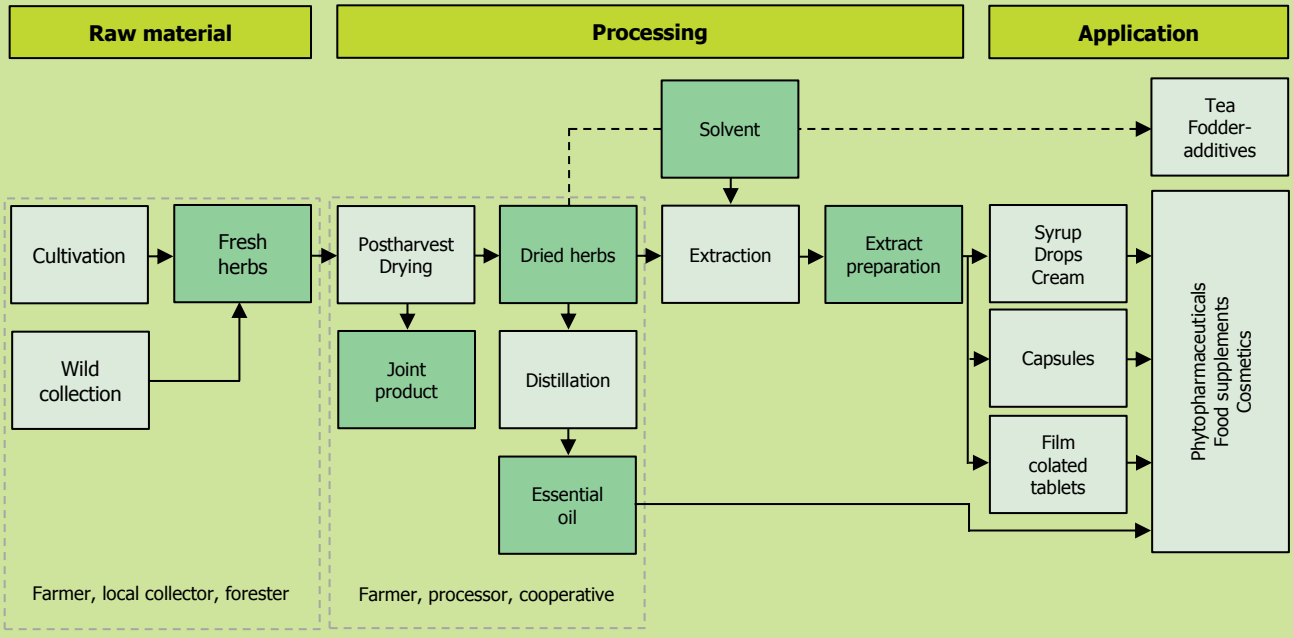

Figure 3 MAP value chain: from raw materials to various plant-based medicinal and cosmetic products.[7]

[7] Schmitz N & Pforte L, 2014. Pharmazeutische Produkte. In: Marktanalyse Nachwachsende Rohstoffe, Fachagentur Nachwachsende Rohstoffe e. V. (FNR), Band 34, pp. 573-674.

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Plant raw material

The production of medicinal plant raw material is very similar to other plant species and is divided in four main steps: **genetic material; propagation; cultivation and harvesting (MP6)**. The active ingredients of medicinal plants are typically localised in different parts, e.g. leaf, flower, seed, fruit, bark, rhizome or root.

Plant raw materials vary significantly in terms of consistency and physical properties. Therefore, the harvesting and processing equipment of individual parts is usually selective. Standardisation of raw material production and quality assurance of MAP ingredients throughout the supply chain begins with the sourcing of verified/certified plant species. The industry worldwide, especially herbal ingredient manufacturers, relies on proper MAPs identification, as described in Pharmacopeia herbal monographs.

Figure 4 Harvesting of herbs in Spain (source: Moré)

On-farm drying process

Postharvest processing and on-farm drying begins immediately to prevent spoilage by enzymatic processes with subsequent quality deterioration. Different dryer types are used for MAPs, e.g., typical grain dryers for seeds, tray dryers for flowers, fruits and roots. Drying of herbs, in turn, is performed in **flat-bed dryers or conveyor-belt dryers,** following low or high mechanised processing lines respectively **(MP7)**.

The **drying behaviour** of MAPs is mainly affected by the conditions of the drying air, such as temperature, relative humidity and velocity. The choice of the optimal drying conditions is a key economic and ecological criterion, as it affects both the quality of production and the energy requirements[8]. To achieve high drying capacity, while saving energy at the same time, a maximum allowable temperature should be applied, but with a minimum deterioration in quality. Drying of MAPs involves low drying temperatures in order to protect the heat-sensitive active ingredients[9]. The energy requirement of MAP drying represents a significant cost factor (e.g., twofold in comparison with grain drying[11]), due to the high moisture content of the individual plant parts to be dried. In general, on-farm storage is very important to both farmers and buyers, since the demand for a continuous and uniform supply of dried medicinal herbs requires advanced traceability tools and short supply routes to the end-use industries.

[8] Müller J & Heindl A, 2006. Drying of medicinal plants. In: Bogers RJ, Craker LE, Lange D (Eds), Medicinal and aromatic plants - agricultural, commercial, ecological, legal, pharmacological and social aspects. Springer, Berlin, pp. 237-252.
[9] Argyropoulos D & Müller J, 2014. Changes of essential oil content and composition during convective drying of lemon balm (*Melissa officinalis* L.). Industrial Crops and Products, 52, 118-124.

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Figure 5 Conveyor-belt dryer of herbs in Germany (source: Argyropoulos & Müller)

On-farm extraction of active ingredients

Extraction of active compounds from MAPs is a key process in the value chain. It requires a technical and operational know-how in order to get the most out of plant matrix, and is therefore carried out by professional companies. **Distillation** is the most common method used to extract and isolate essential oils from MAPs. It is carried out by passing dry steam through the plant material, whereby the steam vaporises the volatile compounds, which then eventually condense and are collected in receivers. The minimum quality requirements for herbal drugs are postulated in the **European Pharmacopoeia** (Ph. Eur.)[10].

Figure 6 Steam distillation of herbs in Italy (source: Primavera)

[10] https://www.edqm.eu/en/european-pharmacopoeia-ph-eur-10th-edition

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Market of plant-based extracts

In a first approximation of the MAP markets, two types of intermediate products can be distinguished:

- Plant materials or parts thereof, whole or cut, fresh or dried
- The extracts, essential oils and oleoresins obtained as the first transformation of the plant material

Both groups of products constitute the raw materials of the perfumery, cosmetics, pharmaceutical, food and chemical industries. A single MAP species may have multiple uses in various end-use industries.

Functional foods

MAPs are used for flavouring: either directly in condiments for seasoning (fresh, frozen or dry) and in herbal teas, or in the form of their derivatives in the industry for manufacturing food products (extract, essential oil):

- Products **addressed directly to the consumer**
  - condiments/seasonings (dried herbs)
  - herbal teas (dried herbs)
- Products **addressed to the industry**
  - food ingredients and additives (flavours, colours)
  - functional food (dried herb, extracts)
  - food supplements (dried herb, extracts, essential oil)

Ingredients for cosmetics

Extracts and essential oils are used to manufacture fragrant products, competing with synthetic compounds:

- Perfumes and other low cosmetic industry products (soaps, moisturising creams, deodorants, insect repellent)
- Drugstore (detergents and air fresheners)
- Scented decoration products

Herbal medicine

Other frontier products are growing market segments, which therefore may present increasing opportunities for MAP producers:

- **Herbal Medicinal Products** are plant-derived health products exclusively containing as active ingredients one or more herbal substances/herbal preparations aimed to treat or prevent disease or to restore, correct or modify physiological functions.
- **Medical Devices** segment comprises a wide range and different kind of tools or objects and substances intended to be used, for diagnosis, monitoring, prediction, prognosis of disease, also for prevention treatment or alleviation of disease or injury.
- **Botanical Food Supplements** are foodstuffs containing high concentrations of nutrients or other substances with a nutritional or physiological effect, marketed in dose form, such as capsules, tablets, sachets of powder and ampoules of liquids.

MAP producers should be aware of the **requirements of the regulatory frameworks**, conditions to understand the opportunities for the utilisation of the plant raw materials. The European Food Safety Authority (EFSA) issued a guidance document on the assessment of the safety of botanical material and preparations[11] and, with reference to the efficacy, published a scientific guidance for stakeholders[12]. The **safety and efficacy** of botanical food supplements (classified according to their intended use and their mechanisms of action) is guaranteed by the whole complex of natural substances and not by individual ones **(MP4)**.

[11] European Food Safety Authority (EFSA) 2009. EFSA Scientific Committee. Scientific Opinion. Guidance on Safety assessment of botanicals and botanical preparations intended for use as ingredients in food supplements. EFSA Journal 2009; 7(9):1249 https://www.efsa.europa.eu/en/efsajournal/pub/1249

[12] European Food Safety Authority (EFSA) 2016. EFSA Panel on Dietetic Products, Nutrition and Allergies. General scientific guidance for stakeholders on health claim applications. EFSA Journal 2016; 14(1):4367 https://www.efsa.europa.eu/it/efsajournal/pub/4367

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Knowledge needs of the key actors in the MAP sector

Farmers wishing to diversify their activity through growing plants used for plant-based medicinal and cosmetic products, and all those active along the value chain should be aware that the sector is "knowledge intensive". The Focus Group identified the different skills and knowledge requirements needed by the actors involved in the MAP sector.

Table 1 Different knowledge needs of the key actors involved in the MAP sector

MAP actors	Skills and knowledge
Collectors	• Good Agricultural and Collection Practices (GACP) • Sustainable wild collection and organic certification • MAP identification, species and habitats • Morphological features for medicinal plant identification • Local chemotypes of MAP subspecies • Regulations and law (EU, national and regional levels) • Nagoya Protocol of the Convention on Biological Diversity • Conservation and use of plant genetic resources • Trade, natural-resource management planning
Herb growers	• Good Agricultural and Collection Practices (GACP) • Good Manufacturing Practices (GMP) • Propagation and cultivation techniques • Harvesting practices and technologies • Quality assurance of plant raw material • Plant water and fertilisation requirements • Weed management and control • Quality, safety and efficacy of herbal drugs • Bulk packaging and labelling • Managerial economics
Plant material suppliers	• Plant genetic resources • Habitat, species and varieties • Active ingredient and content • State-of-the-art and advanced propagation techniques
Input suppliers	• Plant phenology • Plant-soil interactions • Plant nutrition and soil fertility • Common pests, diseases and weeds
Farm machinery manufacturers & technology providers	• MAP-specific production and processing equipment • Automation and control • Irrigation systems • Soil handling machines • Plant protection equipment • Harvesting machines – individual plant parts • Dryer types – MAP specific drying-related data • Distillation units and extraction systems
Primary & secondary processors	• Plant characteristics • Good Manufacturing Practices (GMP) • Postharvest handling and drying operations • Drying behaviour, extraction cycles, energy requirement • Quality criteria and safety (European Pharmacopoeia)

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Multifunctional role of MAPs

The MAP sector is very important for European rural areas, the livelihood of small- and medium-sized producers, and for family-led enterprises. MAPs play a key role in sustainable agriculture and biodiversity. Moreover, they contribute to the stabilisation of micro-climates in rural/marginal regions through their perennial production and rooting systems that are capable of adapting to marginal lands. The regional MAP production systems are characterised by the **establishment of cooperatives**, typically aimed at commercialisation, but which have expanded their role over time and have become integrated into the territorial framework and have combined with other sectors beyond agriculture. A noteworthy particularity of the MAP sector is the varying layers of network participation needed to stay competitive and be resilient against shocks and changing market conditions.

MAPs may be considered a valid tool for the advancement of **agricultural practice towards multi functionality**[13]. They can contribute to economic diversification in rural areas, to aesthetic land valorisation and to creating region-specific dynamics for sustainable development of many areas – especially when these are marginal or at risk of marginalisation. Various plant species find optimal growth conditions in Mediterranean environments. The Mediterranean basin can be the epicentre of economic diversification and sustainable development, e.g. the exploitation of low input agricultural productive systems, medicinal agroforestry, bio-economy and agro-touristic activities. MAPs combat soil erosion, help to mitigate climate change by fixing substantial amounts of carbon dioxide, and play a role in preserving traditional landscapes and maintaining biodiversity. Therefore, in the Mediterranean region the traditional MAP production may contribute to the configuration of areas of high environmental and landscape value. It also represents an important factor in generating employment and income for these MAP-producing regions. All these challenges in the MAP sector can be approached with **social innovations** and/or by **new business models**.

To ensure the continued success of the MAP sector in rural areas, specific actions must be taken. These must among others include the development of innovation, the promotion of product quality, a greater professionalisation, the efficient structuring of inter-sector partnerships, the promotion of well-integrated and suitably-sized marketing structures. Moreover, the risk of lands becoming abandoned or marginalised highlights the importance of **non-commercial functions of this sector,** such as the provision of public goods, the production of healthy, high-quality products, the maintenance of rural population and local production systems. For instance, medicinal agroforestry – where medicinal plants are grown with multipurpose trees – can be a profitable alternative to traditional cropping systems. This system is more sustainable than a mono-cropping system and also provides economic and environmental benefits.

Figure 7 Left: Medicinal agroforestry in Spain (source: Moré); Right: Agro-tourism activities (bird watching) in France[14]

[13] Carrubba A, Catalano C, Bontempo R, 2008. Multifunctional Role of Medicinal and Aromatic Plants: Perspectives and Constraints, Italian Journal of Agronomy, 3, 438-440.
[14] https://www.herdade-valecovo.com

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Success stories

Some good practices on cooperative-specific business models in the MAP sector are presented below.


Source: Eirini Vourloumis/The New York Times/Redux

Chios Mastiha Growers Association (Greece)

www.gummastic.gr/en

The Chios Mastic Growers Association is a cooperation which comprises 4,500 families that reside on the island and cultivate a unique and indigenous product that plays an important role in the economy of the island. Chios Mastiha is the name of a resinous sap produced from the mastic tree (*Pistacia Lentiscus* var. Chia). It is a natural, aromatic resin in teardrop shape that falls on the ground in drops from superficial scratches induced by cultivators on the tree's trunk and main branches with sharp tools. The know-how of cultivating Mastiha has been included by UNESCO on its Representative List of the Intangible Cultural Heritage of Humanity.

Krokos Kozanis Cooperative (Greece)

krokoskozanispdo.eu

A cooperation developed to support over 1,500 families in 20 villages around the area of Kozani. These families grow and collect what is considered to be one of the best organic saffron varieties worldwide. Over 150,000 flowers are collected by hand to produce just over two pounds of saffron. The cooperative has the complete responsibility to collect, process, pack and distribute the product in order to ensure its quality and to avoid the adulteration done by traders in the past that resulted in the degradation and negative image of the product.


Source: Alkis Konstantinidis/Reuters

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Source: Hemp cooperative Ireland

Hemp cooperative Ireland
hempcooperativeireland.com

A group of farmers have come together to form the Irish Hemp Growers and Processors Association, with plans also underway to establish a fully recognised hemp cooperative. The hemp cooperative of Ireland is a registered cooperative with the aim of creating an infrastructure for farmers and local businesses to develop the hemp industry in Ireland. The cooperative will support its members by providing shared access to resources, equipment and markets through a national body and local hubs.

Innovation examples

Under the Sun
www.underthesun.pt

'Under the Sun' is a local small-scale herb production and processing centre which represents an association of five organic herb producers, located in the south of Portugal, where different herbs are cultivated on a marginal, previously abandoned piece of land. For herb drying, a patented modular hybrid solar dryer is used.

Black Block® is a modular, hybrid solar drying system using both solar and electric energy, designed to dry herbs and other crops in recycled black containers, insulated with a new wall and covered by polycarbonate sheets. The hybrid solar dryer consists of the solar collector, where the air used in the drying process is heated, and the drying container, where the material to be dried is placed in sacks, trays or trolleys. Automatic control of drying conditions in the container is achieved by real-time acquisition and analysis of temperature and humidity data through a network of sensors and artificial intelligence. Air is heated throughout the day in the solar collector. However, in conditions of low radiation intensity (a cloudy sky or night time operation), the dryer activates the auxiliary heating system. Practical experience highlights significant savings in energy costs **(https://blackblock.eu/)**.

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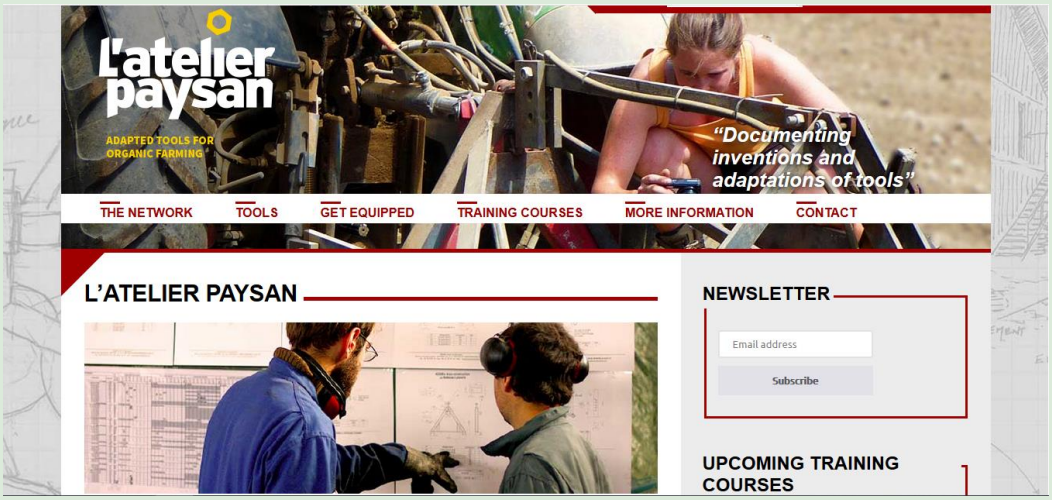
L'atelier paysan
www.latelierpaysan.org

L'atelier paysan is a tool box of farmer-driven technologies and practices: a French-speaking collective of small-scale farmers, employees and agricultural development organisations, brought together in the form of a cooperative. Based on the principle that farmers themselves are innovators, L'atelier paysan has collaboratively developed methods and practices to reclaim farming skills and achieve self-sufficiency in relation to the tools and machinery used in organic farming.



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Funded research projects

Only a few large-scale research projects dealing with the priorities of the Focus Group on plant-based medicinal and cosmetic products have recently been carried out or are currently ongoing across Europe.

These activities are funded under EU programmes managed by the European Commission in the areas of research, innovation and competitiveness – in particular the Horizon 2020 Framework Programme, the Erasmus+ Programme and the European Territorial Cooperation (INTERREG) as well as national research and demonstration initiatives.

Some examples of funded activities are listed below to illustrate the complexity of the topic and to highlight that a multi-actor approach is needed to address challenges and grasp opportunities for farmers/foresters in the MAP value chain.

Table 2 National or international research and innovation activities in the MAP domain

Project type	Project title	Country
H2020 Thematic Network (2016-2019)	Innovation Networks of Cork, Resins and Edibles in the Mediterranean basin (INCREdible) https://www.incredibleforest.net/	EU
H2020 ITN (2017-2020)	Research Training Network on the Microbial Enhancement of Bioactive Secondary Metabolite Production in Plants (MICROMETABOLITE) http://micrometabolite.eu/wordpress/	EU
Interreg Sudoe (2016-2018)	Valorisation of Aromatic and Medicinal Plants: Sustainable management of plant biodiversity and socio-economic development in rural areas of SUDOE (VALUEPAM) http://www.valuepam.eu/	EU
Erasmus+ (2015-2017)	Adult training on handicraft production of medicinal and aromatic plants (HERBARTIS) https://herbartis.wordpress.com/	EU
Erasmus+ (2014-2016)	Integration of good practices and new methods for professional training in the field of herb processing for food and supplements (GOODHERBS) http://good-herbs.eu/	EU
National project (2019-2022)	• Alkaloidhaltige Verunreinigungen in Arzneipflanzen erkennen und entfernen • Unkräuter in Arzneipflanzen ohne Herbizide regulieren https://www.fnr.de/projektfoerderung/ausgewaehlte-projekte/	Germany
National project (2018-2021)	Kostengünstiger und energieoptimierter Arzneipflanzentrockner in Modulbauweise https://www.fnr.de/index.php?id=11150&fkz=22021317	Germany
National project (2017-2020)	Bestäubungsmanagement im Arzneipflanzenanbau https://www.fnr.de/index.php?id=11150&fkz=22001116	Germany
National project (2018-2020)	Développement d'outils génomiques permettant la caractérisation et la sélection des variétés de lavande https://www.iteipmai.fr/71-nos-projets/268-genolavande	France
National project (2017-2020)	Réponses aux Evolutions Climatiques par l'Innovation et les Techniques Alternatives dans les Lavanderaies https://www.iteipmai.fr/71-nos-projets/269-Recital	France
National project (2017-2020)	Growing Genetic Diversity of Medicinal and Aromatic Plants http://www.videsinstituts.lv/en/projects/bioeconomy/genetic-diversity-of-medicinal-and-aromatic-plants.html	Latvia

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4. What can be done

Knowledge exchange and training

The Focus Group recognised the **dynamic roles of both advisers and herb producers,** and the importance of trust to enhance impact. In line with today's 'Digital Era', the use of visual and digital aids in the MAP sector have the potential to facilitate knowledge exchange and training. This may include video clips, factsheets, infographics or webinars to demonstrate skills training and research findings. Such knowledge transfer tools can ease learning experiences and can enhance learning ability and information retention. **Digital tools and platforms** enable growers to have instant access to a broad range of information in a user friendly, non-location dependent format at a time most suitable to their working routine, and which are compatible with multiple devices. Moreover, **on-farm demonstration activities** can provide an ideal opportunity for providing training to industry and relevant stakeholders in the MAP sector.

Figure 8 Left: Field day event in France; Right: On-farm demonstration in Spain (source: Moré)

Demonstration activities can range from one-off 'field day events', to multi-year 'monitor farms' where farmers, advisers and industry members come together to assess farming opportunities in practice, to permanent 'research farms' where researchers test and demonstrate innovative practices and techniques.

Useful links in the MAP domain

European Herb Growers Association (EUROPAM)	http://www.europam.net/
European Medicines Agency (EMA)	www.ema.europa.eu
European Forest Institute (EFI)	https://www.efi.int/
European Agroforestry Federation (EURAF)	http://euraf.isa.utl.pt/
European Industrial Hemp Association (Eiha)	https://eiha.org/
Verein für Arznei- und Gewürzpflanzen SALUPLANTA e.V.	http://www.saluplanta.de/
Deutscher Fachausschuss für Arznei-, Gewürz- und Aromapflanzen (DFA)	https://www.dfa-aga.de/
Forschungsvereinigung der Arzneimittel-Hersteller e.V. (FAH)	http://www.fah-bonn.de/
Fachagentur Nachwachsende Rohstoffe (FNR)	https://www.fnr.de/
Federazione Italiana dei Produttori di Piante Officinali (FIPPO)	http://www.fippo.org/
Instytut Włókien Naturalnych i Roślin Zielarskich	https://www.iwnirz.pl/
Association of Medicinal and Aromatic Plants of Greece (AMAPs)	https://eng.eaffe.org/
Asociación Nacional Interprofesional de Plantas Aromáticas y Medicinales (ANIPAM)	http://www.anipam.es/
Plantes à Parfum, Aromatiques et Médicinales (PPAM)	https://www.ppamdefrance.com/
Établissement national des produits de l'agriculture et de la mer (FranceAgriMer)	https://www.franceagrimer.fr/
Órganisme français qualifié de recherche pour le développement des plantes à parfum, médicinales et aromatiques (iteipmai)	https://www.iteipmai.fr/

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Ideas for new Operational Groups and other innovative projects

EIP-AGRI Operational Groups (OGs)[15] are financed under the Rural Development Programmes and bring together farmers, researchers, advisors, environmental groups, agri-businesses and NGOs to identify innovative solutions to particular challenges facing the agri-food sector and rural economy. At present, only a few ongoing OGs working on topics relevant to the priorities of the FG can be retrieved from the OG database[16].

Latvia	Development of medicinal food for patients of malnutrition/dysfagia creating a new, nationally significant product with a high added value	2018-2021
Italy	Development of Tuscan hop cultivation for the production of beer made in Tuscany	2019-2021
Portugal	Nature Bioative Food	2017-2020

However, it is possible that other OGs active in this area will be included in the database at a later stage. Regardless, the Focus Group identified ideas which may inspire new OG or other innovative projects, covering a spectrum of innovative solutions in the MAP sector, and which can be implemented all over Europe. The Table below presents these ideas by theme and provides a short description of the proposed solutions.

Table 3 Ideas for Operational Groups and other innovative projects in the MAP domain

No	Theme	Description
	Business models and empowerment of MAP producers	
1	Business incubator, science and technology parks **(MP2)**	Create a business incubator that helps new and start-up companies to develop by providing services such as training, sharing machinery and equipment, and improving skills and products before proceeding further with investments.
2	Co-operative society of growers and agricultural businesses **(MP2)**	Create promising organisational concepts to link up the herb farms and raise their profitability, e.g. shared processing facilities, establishment of machinery rings and optimization of harvesting, separation, drying, storage and transportation.
	Multi functionality, ecosystem services and social benefits	
3	A multifunctional herb farming model for urban and peri-urban areas **(MP3)**	In areas surrounding cities, develop a multifunctional herb farming model that has the potential to scale up in terms of number of producers (both growers and wild collectors).
4	MAP interactions in agroforestry ecosystems **(MP3)**	Design agroforestry systems that include MAPs in different social, soil and climate conditions.
5	Transition to agroecology and organic production of MAPs **(MP3)**	Develop a protocol that helps growers in the transition to agroecology and organic farming, taking into account economic, technical and regulatory aspects.
	Quality assurance and certification	
6	Quality assurance of cultivated and wild collected MAPs **(MP4)**	Develop and implement safety and quality assurance measures in order to ensure a steady, good quality and sustainable supply of medicinal plant raw materials.
	Sustainable wild-collection	
7	Innovative tools for sustainable use and management of wild resources **(MP5)**	Develop technical and organisational innovations that help to build forest strategies linked to the sustainable wild-collection of MAPs and that guarantee a diversity of ecosystem services.
8	Profitability of new technology	Monitor harvesting of wild resources and improve resource

[15] https://ec.europa.eu/eip/agriculture/en/eip-agri-operational-groups-%E2%80%93-basic-principles
[16] https://ec.europa.eu/eip/agriculture/en/eip-agri-projects/projects/operational-groups

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	application to enhance resource management efficiency **(MP5)**	management through the adoption of remote sensing technologies, simulation models and physiology.
	Agroecology, domestication and cultivation	
9	Optimisation of the production potential of indigenous wild plant species **(MP5 & MP6)**	Explore the cultivation potential of new wild plant species under climate and site-specific requirements, as well as assessing commercialisation opportunities.
10	MAP cultivation in abandoned and marginal lands **(MP5 & MP6)**	Demonstrate the cultivation of regionally important plant species in identified abandoned and marginal lands through the implementation of sustainable agronomic protocols for cultivation at a large scale.
11	Data assimilation from the soil-plant-climate sensor network **(MP6)**	Test the use of sensors to monitor environmental data related to the air-plant-soil nexus; this should include the integration of multi-source data (e. weather, soil humidity, plant growth) collected on-farm.
12	Irrigation system optimisation in MAP production **(MP6)**	Provide a user-friendly solution for site-specific irrigation, which takes into account the actual water need of specific plant species.
13	Agronomic cultivation protocols for local MAP species **(MP6)**	Implement sustainable agronomic protocols for the reduction of MAP cultivation-required inputs.
14	Advanced cultivation techniques **(MP6)**	Increase the production efficiency and enhance the quality of MAPs. The concept can be evaluated on regional level first, with the potential for different regions and plant species possibly being assessed later.
15	Decision support tool to manage Pyrrolizidine Alkaloids occurrence in MAP production **(MP6)**	Design, develop and test a decision support tool which will allow growers to protect MAPs efficiently against Pyrrolizidine Alkaloids.
	Postharvest processing, drying and valorisation	
16	Automated platform for drying and postharvest management in the MAP sector **(MP7)**	Design, develop and test an integrative computer tool, aimed at the MAP production and processing sectors, as well as companies supplying technology for drying control.
17	On-farm drying optimisation **(MP7)**	Optimise the efficiency of existing different dryer types, e.g. box, container and conveyor-belt dryers for model MAP species.
18	Portable, energy-smart dryers for MAPs **(MP7)**	Construct portable drying equipment adapted to grower needs and plant material specifications.
19	On-farm distillation units **(MP7)**	Demonstrate the implementation of innovative essential oil distillation units and process optimisation in terms of yield and energy performance.
20	On-farm extraction of active ingredients and development of herbal medicinal products **(MP7)**	Optimise on-farm extraction of active compounds from MAPs taking into account process specific variables such as solvent to be used, dried drug/solvent ratio, number of extractions in sequence, extraction temperature and time.
21	Valorisation of by-products and waste from MAP processing into novel value-added products **(MP7)**	Manage the by-products and waste generated in large volumes during postharvest handling and distillation through profitable valorisation technologies.
22	Networking platforms for sharing information with MAP producers **(MP8)**	Design, develop and test a model digital platform that facilitates knowledge and know-how transfer, both for growers and foresters.

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Research needs from practice

In addition, the Focus Group has identified research needs from practice, specifically working on themes around domestication and cultivation; conservation and sustainable use of wild resources; postharvest technologies, drying and extraction; product development & value addition; access to markets; logistics and distribution.

Table 4 Research needs from practice in the MAP domain

No	Theme	Description
	MAP value chain analysis	
1	Value chain analysis and associated challenges **(MP1)**	Carry out value chain analysis in terms of a life cycle assessment, an impact assessment and a commodity chain analysis (e.g. measuring the balance of power between participating actors).
2	Marketing and consumer studies **(MP1)**	Perform country specific marketing and consumer research to identify consumer perceptions of different plant-based products.
3	Database on production of MAP species **(MP1)**	Develop a common database on MAPs: farmers and end users throughout Europe will benefit from this new database.
	Digitisation and automation	
4	Decision support systems, sensors and digital tools to support decision making **(MP2)**	Develop a practical tool for growers or cooperatives, who wish to make informed decisions related to on-farm production and processing operations based on multi-source data integration.
	Multi functionality, ecosystem services and social benefits	
5	Research on multifunctional forest management **(MP3)**	Explore the full potential of non-wood forest products (e.g. forest fruits, mushrooms, cork, pine nuts medicinal plants, essential oils etc.) in rural development.
	Quality assurance and certification	
6	Yield, quality, chemical composition of active substances **(MP4)**	Assess the impact of agronomic parameters on yield, quality and chemical composition of selected MAPs.
7	Improved quality assurance along the value chain **(MP4)**	Improve quality and safety monitoring of MAP raw materials and plant derived products; and test the use of optical sensors.
	Agroecology, domestication and cultivation	
8	Climate change adaptation of medicinal plant species **(MP5)**	Assess the effects of climate change on medicinal flora in terms of their life cycle, secondary metabolites and the distribution of specific plant species.
9	Sustainability aspects of cultivation and wild collection **(MP5 & MP6)**	Identify the conservation benefits and costs of the different MAP production systems in Europe in order to help guide better species conservation.
10	Tools to enhance the genetic diversity **(MP5 & MP6)**	Develop molecular markers as a tool for exploring genetic diversity for crop improvement.
11	Exposure of MAPs to Pyrrolizidine Alkaloids **(MP6)**	Undertake efforts to collect more data on the Pyrrolizidine Alkaloids identified, understand the mechanism of contamination, sources of exposure, level of toxicity and updated risk management.
12	Innovation in plant propagation **(MP6)**	Develop conservation tools for certain endemic MAPs (profitable and/or highly endangered). Explore the effects of commercial captive breeding and artificial propagation on wild species conservation.
13	Advanced cultivation techniques **(MP6)**	Adapt vertical farming technologies including aeroponics, hydroponics and aquaponics.
	Postharvest processing, drying and valorisation	
14	Mechanisation and automation technologies **(MP6 & MP7)**	Demonstrate how combinations of agricultural machinery and dedicated control systems can increase the efficiency of plant raw material production, processing and product manufacturing.

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15	Database on sorption isotherms of model MAP species **(MP7)**	Develop a database on the moisture sorption isotherms of important MAP species.
16	Optimal drying conditions of model MAP species **(MP7)**	Experiment with a range of drying conditions and their effects on the active ingredients of important MAP species.
17	Technologies to improve efficiency, quality and safety of MAPs **(MP7)**	Farm demonstrations of state-of-the-art and emerging drying technologies.
18	By-product valorisation **(MP7)**	Develop farmer-led and low-cost green biorefineries in the MAP sector.

Conclusions

MAPs may be regarded as industrial crops because their products can be used in different industrial sectors beyond agriculture, such as in pharmaceutical or flavour and fragrance industries. With an increasing demand for these plants and their value-added products, a number of business opportunities may arise that can contribute to the sustainable development of resource-efficient and economically profitable crops in rural areas. A steady supply of plant raw materials in Europe can be guaranteed through the domestication and cultivation of MAPs, which in some cases may contribute to the conservation of over-exploited plant species. However, cultivation of MAPs in Europe is still very small compared to other crops. The fact that the majority of medicinal herbs are collected from the wild and/or imported from outside the EU, appears as a good opportunity to intensify the domestic production and processing of MAPs. Frontier products such as herbal medicinal products, medical devices, botanical food supplements and natural cosmetics are growing market segments, which thereby are linked to increasing opportunities for MAP growers. However, to ensure overall quality, efficacy and product safety, raw material sourcing and primary processing (e.g. postharvest handling, drying and extraction of bioactive compounds) are key steps.

Information on the production, wild collection of, and trade in MAPs is scarce and data are rarely collected or published at a national level and European level. The Focus Group highlighted the need for legislative and policy support for wild-harvesting schemes. Given their positive impacts to local economies and their higher value to local collectors, sustainable collection is often considered as the most important conservation strategy for wild plant species. On this point, the Nagoya Protocol of the Convention on Biological Diversity creates greater legal certainty and transparency for both providers and users of genetic resources.

MAPs may be considered as a valid tool for a multifunctional development of agricultural activity. Besides technological innovations, there is broad interest in the use of social innovation to increase the territorial capital through diversification of landscapes, preservation of biodiversity, cross-sectorial and territorial integration, and combinations with other sectors like bio-economy activities and agro-tourism in rural areas.

Analysis of current research results clearly showed that only a few large-scale projects that align with the priorities of the Focus Group have been recently carried out or are currently ongoing across Europe. This indicates an urgent need for fundamental, applied and collaborative research in the MAP domain.

The Focus Group recognised the dynamic roles of both advisers and herb producers, and the importance of trust to enhance impact. In line with today's 'Digital Era', the use of visual and digital aids in the MAP sector have the potential to facilitate knowledge exchange and training. Digital tools and platforms will enable growers to have instant access to a broad range of information in a user friendly format. Moreover, farm demonstration activities can provide an ideal opportunity for providing training to industry and other relevant stakeholders involved in the MAP sector.

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Annex I. Members of the Focus Group

Name of the expert	Profession	Country
Moré Palos, Eva	Adviser	Spain
Olsanska, Gabriela	Adviser	Czech Rep.
Primavera, Andrea	Adviser	Italy
Rode, Janko	Civil servant	Slovenia
Carmody, Kate	Farmer	Ireland
de Jongh, Willemijn	Farmer	Portugal
Księżopolski, Robert	Farmer	Poland
Mikulcic Jakopovic, Snježana	Farmer	Croatia
Peycheva-Miteva, Galina	Farmer	Bulgaria
Redek, Jernej	Farmer	Slovenia
Zapušek, Alenka	Farmer	Slovenia
Cogliandro, Alessia	Industry	Belgium
De Paoli, Alexandra	Herbal therapist	Sweden
Fernandez Moya, Jesus	Forester and land owner	Spain
Freire Cavaleiro, Carlos Manuel	Researcher	Portugal
Frémondière, Guillaume	Researcher	France
Grigoriadou, Katerina	Researcher	Greece
Nicola, Silvana	Researcher	Italy
Schunko, Christoph	Researcher	Austria
Cortegano, Marta	Representative of an NGO	Portugal

Facilitation team	
Argyropoulos, Dimitrios	Coordinating expert
Karasinski, Céline	Task manager
Fernandez-Lopez, Susana	Co-task manager
Ganci, Eleonora	DG AGRI contact person (Horizon 2020/Europe)
Zona, Antonella	DG AGRI contact person (European Innovation Partnership)

You can contact Focus Group members through the online EIP-AGRI Network.
Only registered users can access this area. If you already have an account, you can log in here
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Annex II. List of FG35 Mini Papers

No.	Topic	Coordinator	Contributors
MP 1	Main actors, markets and collaboration of MAPs value chain	Katerina Grigoriadou	Kate Carmody, Marta Cortegano, Alenka Zapušek, Eva More, Dimitrios Argyropoulos
MP 2	Business models and empowerment of farmers/collectors in the value chain	Andrea Primavera	Marta Cortegano, Eva Moré, Kate Carmody, Jernej Redek, Dimitrios Argyropoulos
MP 3	Benefits of MAPs for farming/forest systems: multi functionality, ecosystem services and social benefits	Marta Cortegano	Willemijn de Jongh, Gabriela Olsanska, Snjezana Mikulcic Jakopovic, Jesus Fernandez-Moya, Dimitrios Argyropoulos
MP 4	Plant raw materials for herbal medicinal products, botanical food supplements and frontier products: requirements for quality, safety and efficacy	Carlos Manuel Freire Cavaleiro	Guillaume Frémondière, Alessia Cogliandro, Dimitrios Argyropoulos
MP 5	Wild collection: policy recommendations to avoid over exploitation, sustainable use of wild resources	Robert Księżopolski	Gabriela Olsanska, Jesus Fernandez-Moya, Christoph Schunko, Eva Moré, Willemijn de Jongh, Janko Rode, Alexandra De Paoli, Dimitrios Argyropoulos
MP 6	Technical needs in the primary sector (propagation, cultivation, harvesting, weed management)	Guillaume Frémondière	Andrea Primavera, Katerina Grigoriadou, Silvana Nicola, Willemijn de Jongh, Dimitrios Argyropoulos
MP 7	Postharvest handling and drying of medicinal and aromatic plants	Dimitrios Argyropoulos	Galina Peycheva-Miteva, Andrea Primavera, Katerina Grigoriadou, Guillaume Frémondière, Alenka Zapušek
MP 8	Knowledge exchange, flows and training needs and tools	Eva Moré	Willemijn de Jongh, Janko Rode, Alenka Zapušek, Robert Księżopolski, Alexandra De Paoli, Dimitrios Argyropoulos

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The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as *through* the EIP-AGRI network.

EIPs aim to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- ✓ the EU Research and Innovation framework, Horizon 2020,
- ✓ the EU Rural Development Policy.

An EIP-AGRI Focus Group* is one of several different building blocks of the EIP-AGRI network, which is funded under the EU Rural Development policy. Working on a narrowly defined issue, Focus Groups temporarily bring together around 20 experts (such as farmers, advisers, researchers, up- and downstream businesses and NGOs) to map and develop solutions within their field.

The concrete objectives of a Focus Group are:

- ✓ to take stock of the state of art of practice and research in its field, listing problems and opportunities;
- ✓ to identify needs from practice and propose directions for further research;
- ✓ to propose priorities for innovative actions by suggesting potential projects for Operational Groups working under Rural Development or other project formats to test solutions and opportunities, including ways to disseminate the practical knowledge gathered.

Results are normally published in a report within 12-18 months of the launch of a given Focus Group.

Experts are selected based on an open call for interest. Each expert is appointed based on his or her personal knowledge and experience in the particular field and therefore does not represent an organisation or a Member State.

*More details on EIP-AGRI Focus Group aims and process are given in its charter on:
http://ec.europa.eu/agriculture/eip/focus-groups/charter_en.pdf

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Join the EIP-AGRI network & register via www.eip-agri.eu

servicepoint@eip-agri.eu | +32 2 543 73 48 | Koning Albert II laan 15 | Conscience Building | 1210 Brussels | Belgium