WildFood

WildFood Project

Eating the wild: Improving the value-chain of Mediterranean Wild Food Products (WFP)

Report on the state-of-the-art of the WFP value-chains.

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Executive summary

Wild food trade has a world-wide dimension and Europe represents the main global market player. The trade analysis of a set of key target wild food products like pine nuts, truffle, and some aromatic plants (e.g. thyme and bay leaves), allowed to show the effect on pests on pine nuts or specific policies applied to the single products. Data quality and availability play a crucial role in the design of correct policies, which suggest us to use a direct data collection among the economic player of the supply chain, in order to describe in deep, the efficiency and constraints of the actual wild food chains.

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1. An introduction of wild food trade.

The wild food trade has had an international dimension in the whole human history and probably, the production and commercialization of wild foods can be considered the most ancient human economic activities (Zohary, et al. 2013). The historical literature reports several information on the use and trade of wild products, which are more addressed to ethnobotanical aspects rather than economic information. Only in the late '80s a systematic data collection on trade scale up at global level, when UN Comtrade started to collect and store data gathered by the custom authorities. Today, trade data represent a key-element for understanding the global market trends of product and services, among which still exist products based on wild harvests foods. Despite there is an undefined number and type of wild foods traded at global level, international trade data represents one of the most important information scholars and policy makers have at global scale (Vantomme, 2003). Despite a limited number of wild foods is clearly traced with specific codes under Harmonized System codification, the available data on such products allowed to show global patterns on the use of wild foods or the effect of policies applied at the national or international level. For instance, the substitution effect of wild cranberries with the cultivated ones, or the effect of overexploitation of quebracho that reduced the traded volume commercialized in the international market, are two examples that can be found through the analysis of the international trade data (Pettenella, et al. 2014). Hence, trade data can be used to detect particulate trade trends in specific commodities; for instance, they can be used to analyze the domestication effect on certain species, or the shift from countries with higher to lower purchasing power on the production of a set of wild foods, as well as to study the effect of pests affecting the production of certain products like in the case of chestnuts. In general, trade move products like wild foods from a country where the production costs are cheaper, to a country where the production costs are higher and there is a traditional demand for it. These basic rules allow us to partially understand the evolution of the global trade and how policies applied to wild food and its demand in a given country have been commuted into trade flows. For instance, Mayer, et al. (2005) demonstrated the effect of policies on the importation of certain types of commodities, and how the same policies could contribute to export negative impacts on the environment of third countries. However, in order to interpret appropriately the results of an analysis and understand trade trend and its political implication, all the approaches used to analyze the international trade should utilize metadata and information gathered along the supply chain.

International trade data is able to describe only a segment of the global market, since the majority of wild food consumption occurs at local level or within the national boundaries (Lovrić et al., 2021). Also with regard to wild food production at the country level both in Europe or outside Europe, there is an issue of lacking of reliable data (Forest Europe, 2020) that is rooted in two main problems: the absence of a common definition of wild food; and secondly the way countries classified wild food in the taxation system, because whenever there is a taxation system in place, there is an accountability that must be provided by the producer. It is a common understating that definitions matter in any economic analysis, and any analysis depends on the definition that is used to describe a given economic phenomenon. Wild food and wild food products are wordings rarely used in the forest sector, but commonly propose to communicate to the end user (Kilchling, et al. 2009). Due to the lack of common terms and definitions, WP1 leaders promoted an internal questionnaire in order to shape a suitable definition for the project activities. The questionnaire reported a set of different wordings addressing wild food, and the related definitions available in the literature. Each respondent was asked to propose a value from 1 to 5 for each definition, where 1 means unsuitable for the project and 5 means useful for the project. The results of the survey are reported in Table 1. The result shows a convergence over option 5 and 7, because they obtained the higher score among the other responses. Option 1 and 6 got the same average score weighted per country, even though considering each singular answer, the score in option 1 was quite lower. It is clear the project consortium had no a clear convergence over a single definition, hence we promoted a further internal meeting on the 16th December 2020, where we opted to amend and integrated Muir et al. (2020) definition with the definition provided by Wolfslehner et al. (2019). Finally, conjointly, the team of Portugal (PT), Slovenia (SI), Spain (ES), Tunisia (TN), and Italy (IT) propose to use the following definition: "*Wild food products are untended biological resources other than wood that are used as food and they are obtained from gathering activity in forests and other land. A semi-wild food product can be considered a wild food product subject to some form of human intervention to*

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increase productivity in the place it carries out its biological cycle". The definition can surely improve during the project work, but it helps to develop the boundaries that we analyze and develop in the project and its activities.

Table 1: Wild food definition: internal questionnaire results.

Definitions	average score among respondents	average score weight per country
1. Non-wood forest products (NWFPs) are goods of biological origin other than wood derived from forests, other wooded land and trees outside forests (FAO 1999)	3.44	3.67
2. Non-wood forest products (NWFPs) are goods derived from forests that are tangible and physical objects of biological origin other than wood (FAO 2015)	2.78	2.92
3. Wild food is defined as anything edible that requires no human input to increase its production (Daudet 2012)	3.11	2.92
4. Wild foods are plants, berries, fruit, nuts, mushrooms and game that are collected in the wild, to be consumed as food or drink (Maes et al. 2013)	3.56	3.25
5. Wild forest products s are products other than wood derived from wild and semi-wild forests, as well as from sources in early stages of domestication, such as fruit trees, bushes, and orchards. This definition covers a wide range of resources and products including plants, fungi, fauna and soil (Wolfslehner et al. 2018)	3.89	3.92
6. Wild forest foods are a subset of wild foods and refer to uncultivated foods from forested areas, such as bushmeat, fish, fruits, leafy vegetables, nuts and seeds (not including forest-based agriculture, e.g., shifting cultivation or agroforestry systems) (Rowland et al. 2017)	3.67	3.67
7. Wild forest products are untended biological resources other than wood obtained from gathering in forests and other wooded land. While semi-wild forest products can be considered biological resources other than wood gathered in forests and other wooded land subject to some form of human intervention to increase productivity (Muir et al. 2020)	3.67	3.83
8. A wild product is a species that grows spontaneously in self-sustaining populations outside cultivated areas, in field margins, forests, woodland, grassland, and wetlands (e.g., paddy fields), independently of human activity (Heywood 1999)	3.11	3.17

Note: the score range between 0 and 5, where 0 means "no convergence" and 5 means "total convergence". The average score among the project partners respondents considers the average score of all the answers, while the average score weighted per country, consider the average of the average score of each country.

Why is it so critical to address a common definition on wild food? The answer is not that simple as it can be thought. Any wild product collected in the forest or other natural areas is considered a commercial activity according to the NACE codification of economic activities; however, if the same species cropped in an agriculture field, the production fell inside the farmed products. The same happens in forests managed by a farmer, if the farmer declares to collect that species on purpose. So, what is wild and what is the farmed product? The correct answer must address the way the product is produced, and beyond this small difference there is a huge diatribe among policy makers, where wild food project will aim to suggest and propose a new point of view to boost the most ancient human activity. The effect of the adoption of different definition among European countries can be quite easily seen from main Europe's Forest reports. After a couple of decades of economic studies on forest products, the situation seems to get worse on the data quality and quantity regarding wild foods and in general non-wood forest products. It is a fact that from the first report on Europe's forest, till the lastly published, there is a tendency to report less detailed information even though, in the last years, the volumes and values of non-forest products collected and traded have been increasing (FAO EFI, 2015; Forest Europe, 2020; UNECE-FAO, 2003; UNECE FAO, 2011). Here it comes the reason why, trade analysis is important to study market trends on the few available data a small set of species that can be referred to wild foods. Comtrade and International Trade Centre (ITC) will be used to develop the present deliverable as they represent the main data source for international trade analysis.
Beyond any reported data on wild food products in the international trade databases, there are two or more companies that allow transfer products from one country to another, and their transaction is recorded by the custom office. International trade database record only the transactions that cross physically the border between one or more countries, while the transaction among companies inside a country are generally recorded by the taxation agency. The overall process that takes a product from the forest to the end user is called supply chain. Part of the present deliverable will try to describe synthetically the supply chain of a selected number of species listed in chapter 2; the description will help the development of the other tasks and deliverable of the project.

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The introduction briefly presented the aims of the deliverable 1.1., which will be the trade analysis and a general description of the supply chains that transport wild foods from forest to the end users on a set of target wild food meaningful for the project partners.

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2. Target species for the project development

Among the thousands of wild species traded every year, only a small number is clearly reported in the international statistics. Due to this structural problem, WP1 promoted an internal questionnaire in order to understand the needs of the project partners on a specific number of wild foods. Each project partner indicated one or more target product according to the network and knowledge they had with the companies of the supply chain and their choices are reported in Table 2, Table 3, and Table 4, respectively for nuts, mushrooms and aromatic plants. Unfortunately, as highlighted in Table 4, the target aromatic plants (rosemary, lentisk and myrtle), do not have specific trade hence we decide to report other similar wild products, like bay leaves and wild thyme, in order to show the potential use of trade data, in case in the future there will be added new specific codes.

Table 2: Target wild food for the nuts and pine seed product group

Country	Nut species	Data	Typology of economic stakeholder we are in contact with
Italy	Pine nuts (Pinus spp.)	No data	Wholesalers
Portugal	Acorn (Quercus spp.) + Pine nuts (Pinus spp.)	No data	Producers (included landowners that produce pine nuts), Processors, Wholesalers, Retailers
Spain	Pine nuts (Pinus pinea)	Data available	Producers, Processors, Wholesalers, cooperatives
Tunisia	Pine nuts (Pinus spp.)	Data partially available	Producers (included landowners that produce pine nuts), Processors, Wholesalers

Table 3: Target wild food for the mushroom and truffle product group

Country	Species	Data	Typology of economic stakeholder we are in contact with
Algeria	Summer truffle (Tuber aestivum)	No data	None. It will be reported a general overview of the sector.
Italy	Summer truffle (Tuber aestivum)	No data	Producers (included landowners that produce mushrooms and truffles), Processors, Wholesalers, Retailers
Slovenia	Summer truffle (Tuber aestivum)	No data	Producers (included landowners that produce mushrooms and truffles), Processors, Retailers.
Spain	Black truffle (Tuber melanosporum)	Data partially available	Producers (included landowners that produce mushrooms and truffles), Processors, Wholesalers, Retailers

Table 4: Target wild food for the aromatic plant product group

Country	Specie	Data	Typology of economic stakeholder we are in contact with
Algeria	Rosemary, lentisk and myrtle	No data	Producers (included landowners that produce aromatic plants), Processors
Portugal	Pennyroyal (Mentha pulegium)	No data	Producers (included landowners that produce aromatic plants), Processors, Wholesalers, Retailers
Tunisia	Rosemary and myrtle	Data partially available	Producers (included landowners that produce aromatic plants), Processors

The selection of target species will help the project development on the analysis of the supply chains and, in particular, on the selection and involvement of the companies that allow the products to move from the production area to the end users. The target species will be used to develop Deliverable 1.2 and 1.3 respectively on supply chain actor characterization and to run a comparative analysis among supply chains of the same product in different countries. The findings will support to design policy recommendations in order to boost the economy based on wild foods, considering that 0.5% of European households rely economically on the collection and commercialization of these products (Lovrić et al., 2020).

The questionnaire highlighted also the problem of data availability and quality related to wild food production. Among the project partners, only Spain has data production on wild foods, while Tunisia has partial data gathered on previous projects. The data production situation suggests us to investigate in deep along the supply chain in order to analyze how data are recorded along the supply chain and how policies shape their performances.

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3. European trade trends: an overview on wild foods

The present chapter describes the international trade of a set of target wild foods. Starting with a general description of the source of data on these products, it continues on a detailed description of the trade trends of each specific product analyzed, such as pine nuts, fresh truffle, bay leaves and wild thyme. These last two are examples that are used to describe the importance to have specific codes on aromatic plants, which are grouped today in few trade codes.

3.1. Data source

UNComtrade is today the main data provider for international trade, and it collects all the information processed by each custom organization in each country that ratified the General Agreement on Tariffs and Trade (GATT). The data collection is based on the digitalization of each custom declaration by the customs authorities that record information like value, quantity and type of commodity or services with a special codification that is called harmonized system (HS)[2]. The harmonized system codification is a common way to classify commodities and it can be very specific according to the need to trace a given commodity in the global trade. At the international level, the minimum level required is fixed at 6-digits. Even if there are countries that implemented 12-digit specification, wild foods are better reported with eight or more digits code specification, which is available only in European Union market and US, and for reason, UNComtrade cannot provide complete information about traded wild foods. For instance, the US Bureau records trade information of several wild species and it can record even some products generated from a specific part of a single species. Another example is the European Union, which adopted 8-digits code specification, called combine nomenclature (CN), in the year 1988[3]. Through its statistical portal, Eurostat, European Union measure the value and quantity of goods traded with non-EU countries (extra-EU trade), as well among EU Member States (intra-EU trade), even though these last are recorded in a different way due to the EU free movements of goods[4], hence only a part of the transactions is recorded[5]. Finally, a test has been done with International Trade Centre (ITC) database, which provide similar data as UNComtrade reported.
Among the available data for the selected wild foods by the project partners, Eurostat provides information about pine-nuts and truffle, while acorns, and aromatic plants are not reported with specific trade codes. Table 5 reports the codes we used to analyze the target products.

Table 5: Trade codes of the target products.

CN Code	Description	Period covered
08 02 90 50	Pine nuts (*fruit of the genus Pinus, such as Pinus pinea, Pinus cembra and Pinus koraiensis), whether or not contained in the cone)*	2000-2021
07 09 59 50	Fresh of chilled truffle	2007-2021
09 10 99 31	Wild thyme (Thymus serpyllum)	2007-2021
09 10 99 50	Bay leaves	2007-2021
20 03 90 10	Truffles, prepared or preserved otherwise than by vinegar or acetic acid	2012-2021

Source: EU Regulation 2019/1776

The results show the European trade balances of the products listed in Table 5, with a possible focus on the project partner countries, and if these play a relevant role in the trade. We considered the period from 2000 to 2019 in the trade analysis; moreover all data refers to economic values, without any reference to product weight, due to the lack of reliable data on quantities reported in the database. Unfortunately, target products like Aleppo pine seeds and all the aromatic plants have no specific codes in the international trade database, hence a specific analysis cannot be done.

3.2. Pine nut trade

Pine nuts are a group of products that gather all the pine seeds generated by different species of pine, where the most commons are *Pinus pinea, Pinus sibirica* and *Pinus koraiensis*. The pine nuts code considers both

[2] Harmonized system codification http://www.wcoomd.org/en/topics/nomenclature/instrument-and-tools.aspx
[3] Regulation 2658/87. Combine nomenclature (CN) codes are the European adaptation of the Harmonized system codes
[4] Art. 26, 28 and 37 of the Treaty on the Functioning of the European Union (TFEU) introduced the free movements of goods among signatory European countries.
[5] See threshold settings within European Union member states in the guideline "Compilers guide on European statistics on international trade in goods" - chapter 6: https://ec.europa.eu/eurostat/documents/3859598/7027786/KS-GQ-15-010-EN-N.pdf/a1d7bf4b-525e-4183-963c-00cf231650ee

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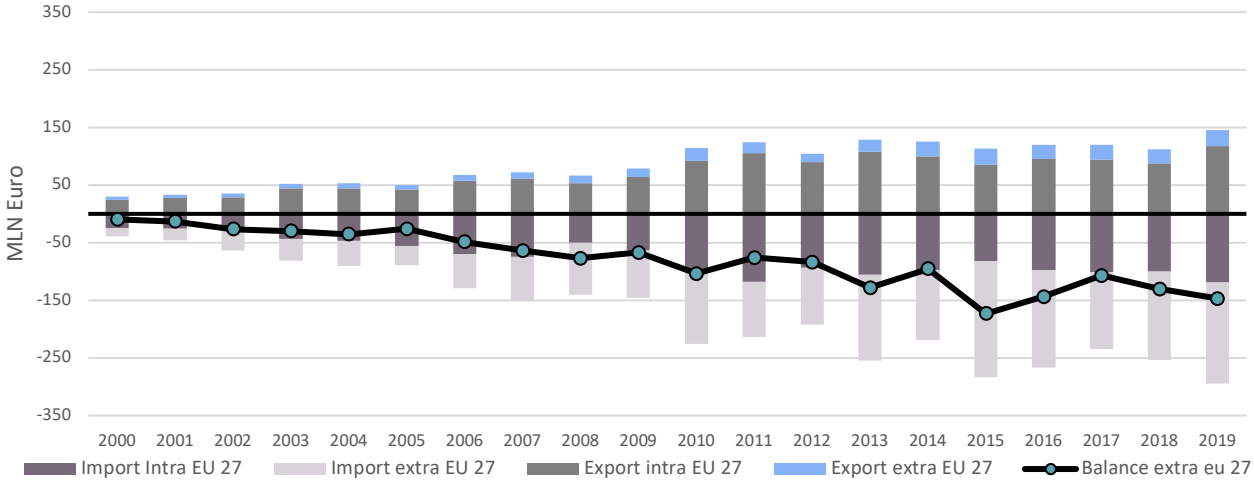
shelled, un-shelled and in-cone pine nuts, regardless the specie (CN code: 0802 90 50). The EU27 trade balance remained negative (Figure 1). In the last decade, the trend of the EU trade balance has increased the import from extra-EU countries, while EU has tripled the import from the year 2000. In fact, in 2019, EU imports of pine nuts from non-EU countries reached € 175 million, while EU exports did not exceed € 30 million. In detail, between 2009 and 2015, the import of pine nuts from outside the EU was characterized by a real boom (+ 250%). This trend is probably due to an invasive parasite that has severely damaged pine nut production in some EU countries in recent years. In this context, China replaced a major EU pine nut producers and it accounted for nearly 80% of EU imports in 2019. China's role as pine nut supplier doubled between 2000 and 2019.

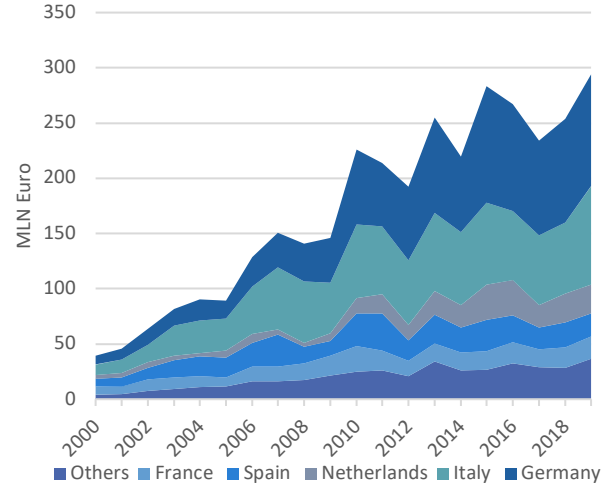
Figure 1: Pine nut EU 27 trade balance



Source: our elaboration on Eurostat (2020) data

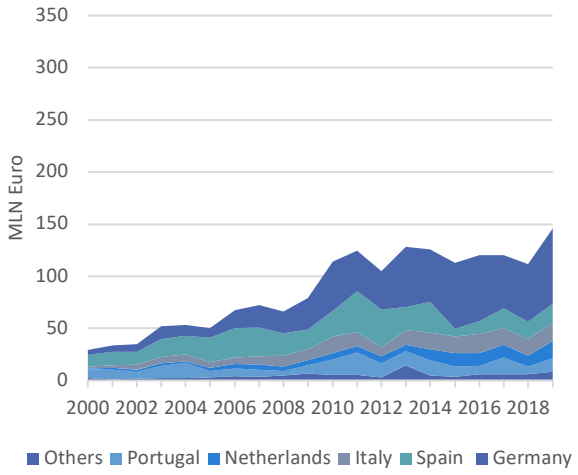
Focusing on the role played by individual EU countries, Germany was the largest importer of pine nuts in the EU in 2019, accounting for 35% of the total EU import (Figure 2). In recent years, Germany has replaced the EU's top historical importers, such as Italy and Spain, as the EU's top pine nut importers. Germany has also emerged as the EU's top pine nut exporter in recent years (Figure 3) and it covered almost 50% of the total exports of European pine nuts in 2019. Germany has become, both in terms of export and import, one of the main European processing hubs of pine nuts. Similarly, in recent years, another country like Netherlands, which is not a traditional producer of pine nuts, has increased its role in terms of import and export of pine nuts and has become another important EU processing of pine nuts.

Figure 2: Pine nuts top importers



Source: our elaboration on Eurostat (2020) data

Figure 3: Pine nuts top exporters



Source: our elaboration on Eurostat (2020) data

As described above, since 2010, the pine nuts production in some specific EU countries had collapsed due to an invasive pest, called *Leptoglossus occidentalis*, that had contributed to damage cones and seeds before

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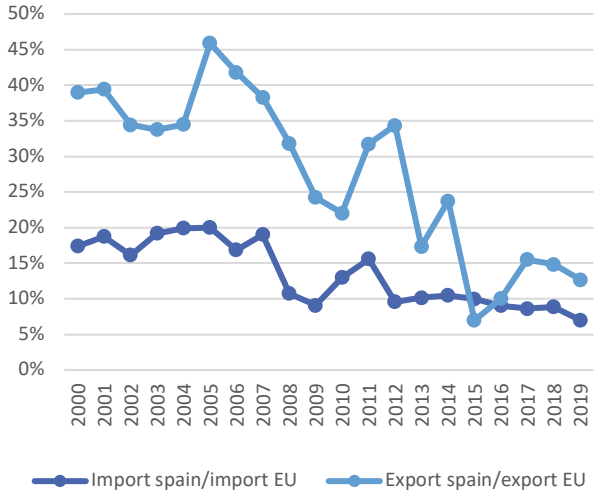
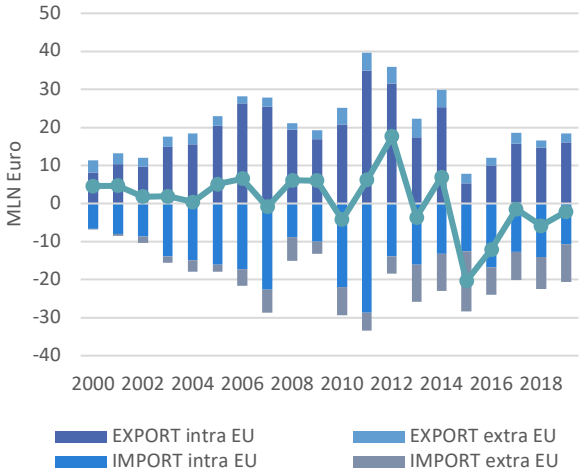
harvesting. For example, Spain, between 2005-2015, had reduced by two-third of its pine nuts export, and its role in the EU context as pine nuts exporter, had strongly reduced (Figure 4). In the same period, in order to satisfy the internal demand, Spanish import of pine nuts has almost doubled. In the last years, main suppliers of pine nuts for Spain are China and Portugal. These two countries, together, in 2019, covered around 90% of Spanish pine nuts import. This recent import and export contributed to make the Spanish trade balance strongly negative in 2015, only after 2016, the Spanish export of pine nuts has begun to increase (Figure 5).

Figure 4: Spanish market share



Source: our elaboration on Eurostat data (2020)

Figure 5: Spanish trade balance



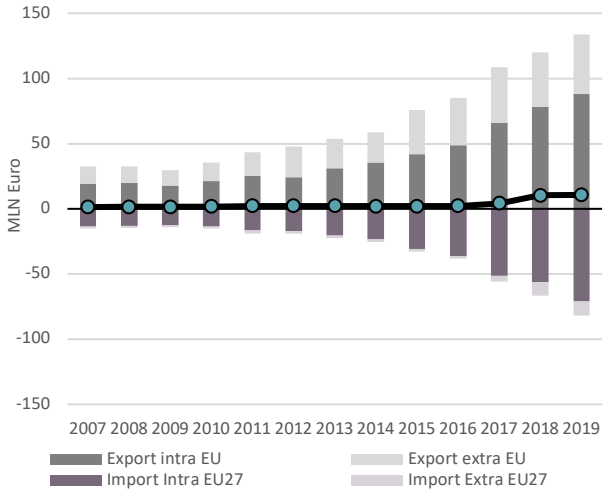
Source: our elaboration on Eurostat data (2020)

It would be interesting to propose a set of new trade codes in order to trace the different species, especially for *Pinus sibirica*, *Pinus koraiensis* and *Pinus domestica*, due to the high difference in price and, moreover, for the economic impact the trade can generate on supply countries. In other terms, the creation of new codes on specific products can detect effect of policies or effect of biotic and abiotic large event at international scale.

3.3. Truffle trade

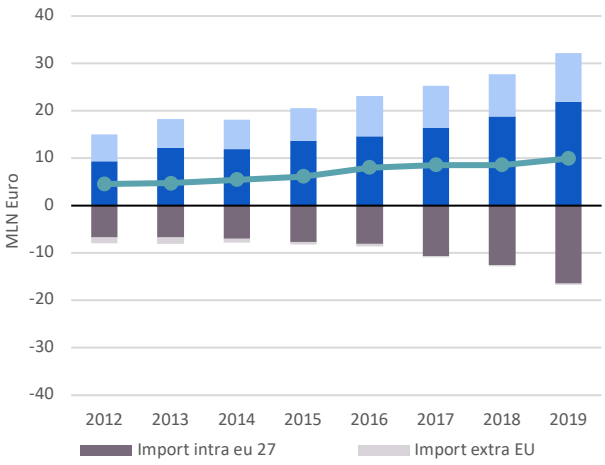
Truffles group up several species of the genus *Tuber*, *Terfezia*, *Tirmania* and *Leucangium* even though the volume and value are mainly linked to three species: *Tuber magnatum* (also known as white truffle), *Tuber melanosporum* (black truffle) and *Tuber aestivum* (summer truffle). This last represents over 90% of the traded volume, but only 40% of the traded value. All fresh truffles are traded with the code 0709 59 50, even though they are traded with different other codes that does not allow to analyze the truffle trade. Another important trade code is the code 2003 90 10 and it refers to prepared truffle in sauce or other foodstuff.

Figure 6: EU27 trade for fresh truffle



Source: our elaboration on Eurostat data (2020)

Figure 7: EU27 trade for prepared truffle



Source: our elaboration on Eurostat data (2020)

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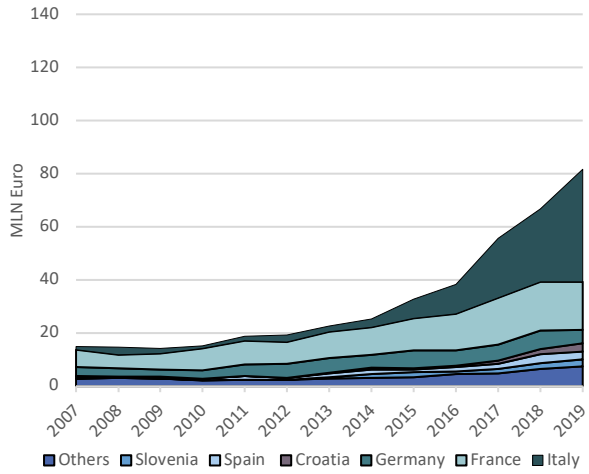
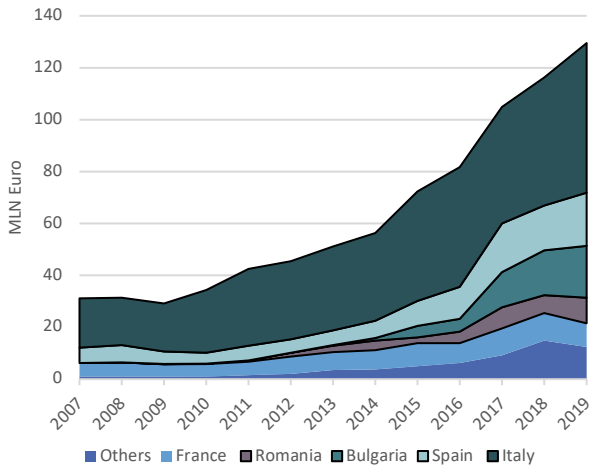
Figure 8: EU27 fresh truffle main importers



Source: our elaboration on Eurostat data (2020)

Figure 9 EU27 fresh truffle main exporters



Source: our elaboration on Eurostat data (2020)

About fresh truffle, during the entire period between 2007 and 2019, EU27 maintained a positive trade balance for fresh truffles. In fact, focusing on non-EU trade, in all the years considered, the EU 27 exported a greater value than imported. After a period of slow growth during the economic crisis between 2007 and 2019, both the import and export of fresh truffles from the EU have been characterized by a rapid increase (Figure 6). This relevant growth in EU trade, in terms of import and export, is also due to a growing global demand for fresh truffle, as well the transformed truffle into sauce and other foodstuff, both in European countries and US (Figure 7). However, in the period 2007-2019, the relative growth of the import of fresh truffles from outside the EU appears to be much more relevant than exports. In fact, between 2007 and 2019, EU imports from non-EU countries increased tenfold, while non-EU exports tripled. This trend shows how, in recent years, the EU internal supply of fresh truffles had not been able to satisfy internal demand and, at the same time, other non-EU countries, in recent years, have structured supply chains destined for export. Among the exporting countries, Iran has emerged as the main EU supplier of fresh truffles since 2017, surpassing the role of Bosnia and Serbia as leader of EU truffle suppliers (Annex I). For instance, Iran covered 60% of the Extra EU fresh truffle import in 2019. It is worth to mention, Iran export to EU-27 was recorded for the first time in 2015, despite UnComtrade recorded it since the early '80s. This is probably due to some trade policies that push EU27 to avoid the formal recoding (Pettenella et al., 2014). Regarding the EU 27 export, during the whole period 2007-2019, United States and Japan remain the main destination of European fresh truffle. The strong and growing EU domestic demand for fresh truffles is also confirmed by the recent trend of the EU trade in prepared truffles. In fact, extra-EU exports of this product are constantly growing, doubling from 2012 to 2019, while import from non-EU countries is extremely marginal (Figure 7). The main destinations of the truffle prepared in Europe are the USA and Switzerland, while the main EU exporters are Italy, France and Spain. Italy alone, 2019, accounted for almost 55% of total EU exports of fresh truffles (Annex I). Focusing on the role of single EU countries, the top five EU fresh truffle importers, in the period 2007-2019, remained the same. However, since 2017, Italy has become the first importer of the EU, overtaking Germany and France, which until 2016 were the EU main importers of fresh truffles (Figure 8). In 2019, Italian import of fresh truffle covered more than half of the EU import. Regarding the EU fresh truffle export, between all the period 2007-2019, Italy remained the main EU exporter. However, among main EU exporters, in recent years, some Eastern European countries, such as Romania and Bulgaria, have emerged as important fresh truffle exporters, replacing the traditional fresh truffle exporters, such as France and Germany, that become net importers. The growing role, in terms of truffle export, of Romania and Bulgaria is mainly due to the cheaper labor costs, which impact on the selling price at wholesaling level. Moreover, wild harvesting has become more common in the easter European countries.

As we have seen in the EU fresh truffle trade, Italy plays a predominant role, and in 2019 it was by far the EU leader, both as an importer and an exporter. Nonetheless, the Italian trade balance has started to decline since 2014, showing a decline in the internal production capacity (Figure 11). In the period between the year

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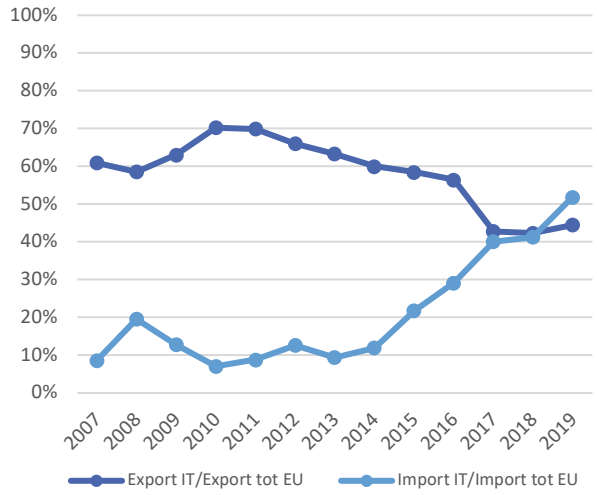
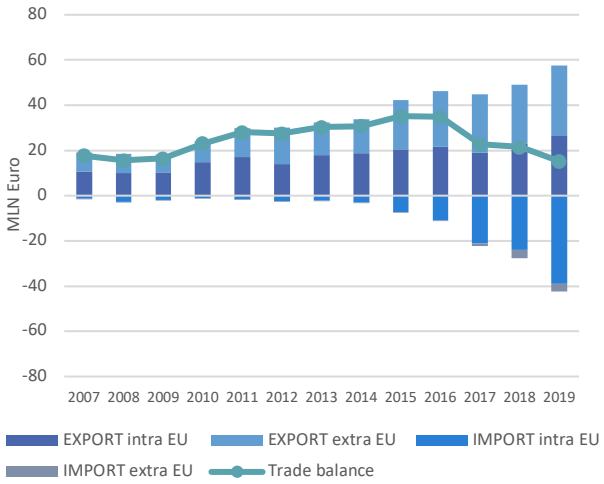
2014 and 2019, the Italian import of fresh truffles has exploded (from 3 million euros to over 40 million euros), while the Italian export of its trade has not registered such strong growth (+ 40%). The main reasons for this trend was linked to legal issue; the companies were not able to purchase with formal transaction, hence the products probably took other informal ways to be legalized (MIPAAF, 2018). In terms of importing fresh truffles, in 2019, the main Italian partners were Bulgaria, Romania, Spain. Iran, on the other hand, is by far the main extra-EU supplier of fresh truffles for Italy. In 2010, the first two suppliers of fresh truffles were different, France and Hungary. In detail, in 2010 France was the main supplier of fresh truffles for Italy, covering a third of Italian imports, while in 2019 the role of France collapsed, covering less than 3% of Italian imports. The lack of internal policies has pushed the Italian processing companies to outsource the procurement of the raw truffle in third countries (Figure 11). The increasing demand of processed products, combined with the absence of policies has a negative effect on the trade balance, pushed the curve toward a steep slope that might push Italy to a negative trade balance in the next few years. Only a strong policy on truffle cultivation may change the trend, but it would increase the raw material costs, which is linked to the high cost of investment on truffle orchards and the long payback period the farmer need to wait to start the production.

Figure 10: Italian fresh truffle trade share



Source: our elaboration on Eurostat data (2020)

Figure 11: Italian fresh truffle trade balance

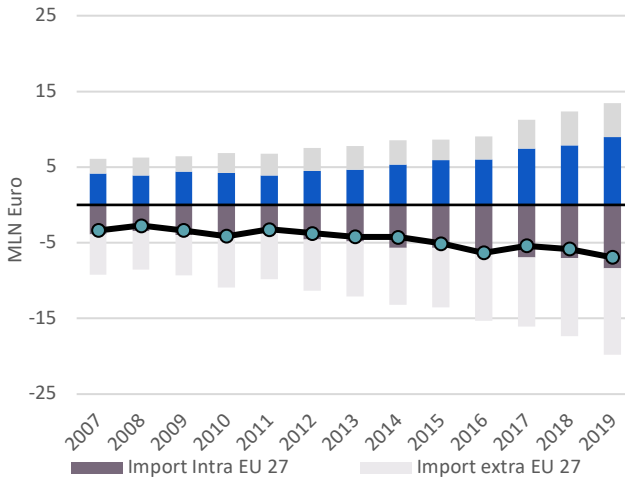


Source: our elaboration on Eurostat data (2020)

3.4. Bay leaves

Bay leaves are collected from bay tree (*Laurus nobilis*) in the Mediterranean area. The use of bay leaves is generally for aromatic purpose to be added in food. Throughout the 2007-2019 period, the European trade balance of bay leaves remained negative. However, in recent years, the trade balance has gradually decreased, due to the continued growth of EU imports, especially from non-EU countries (**Errore. L'origine riferimento non è stata trovata.**). However, it should be noted that the value of the European trade of bay leaves is much lower than that of pine nuts (about ten times lower than pine nuts) and about five times lower than fresh truffles. The main supplier of bay leaves for Europe is Turkey, which in 2019 covered more than 92% of European imports, for a total value of almost 11 M € (Annex I). Since 2007, Poland and Germany have been the two main European importers of bay leaves (Figure 13). However, if in 2007 Germany was the first

Figure 12: EU27 trade balance for bay leaves



Source: our elaboration on Eurostat data (2020)

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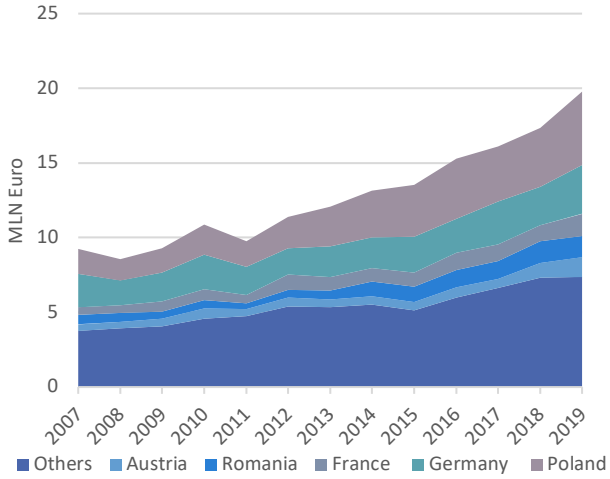
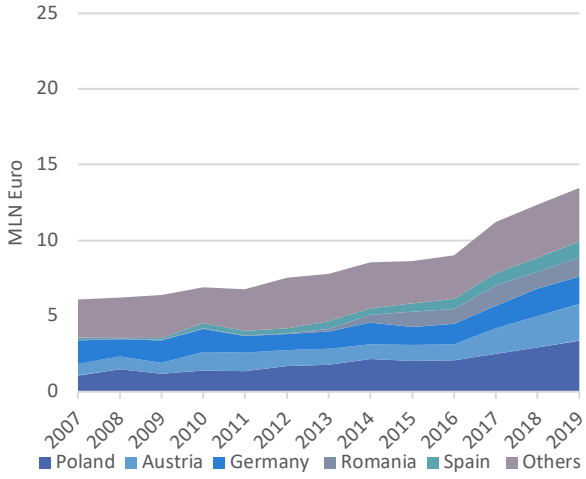
European importer, covering 25% of European imports, and Poland 18%, in 2019 the roles were reversed and Poland, in the last years, became the main EU importer of bay leaves, covered around a fourth of the total EU import (Figure 13).

Figure 13: EU27 import of bay leaves



Source: our elaboration on Eurostat data (2020)

Figure 14: EU27 export of bay leaves



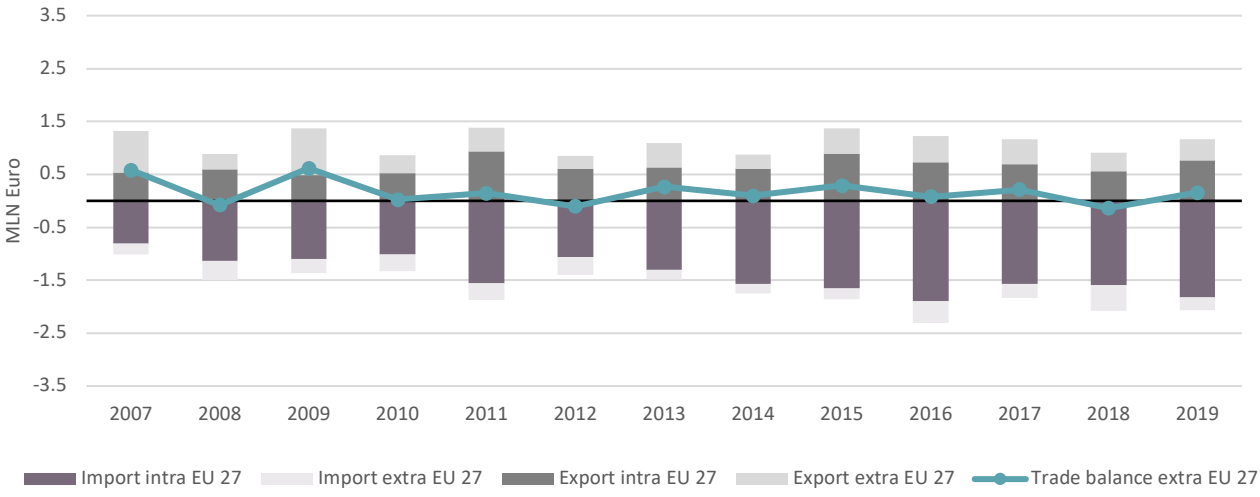
Source: our elaboration on Eurostat data (2020)

Other important EU importers are France and Romania, even if their import of bay leaves, in 2019, did not exceed the value of 1,5 € Million. With regard to EU export of bay leaves, Poland and Austria are the main EU exporters of bay leaves, mainly towards to European countries (Figure 14). The reported analysis allows to show how important would be to have a specific trade code for the aromatic species indicated in Table 4, which are today traded within different commodity codes.

3.5. Wild thyme

Thyme is a term to group different species of the genus *Thymus*. The plant grows in the dry land in Mediterranean countries. The traded value of wild thyme appears marginal, if compared with other wild foods. Trade flows outside the EU are limited and both in import and export. In the period 2007-2019, trade did not exceed 0.5 M€ (Figure 15). Over the same period, EU imports and exports from non-EU countries have remained very similar, in terms of value, and this brings the EU trade balance close to zero. Whereas the value of wild thyme traded in the EU-27 (focusing on intra-EU imports) in 2019 was around € 1.5 million. The main extra-EU suppliers of wild thyme are Israel and Tunisia, but in 2019 the value of their exports to the EU-27 did not exceed 50,000 euros.

Figure 15: EU27 trade balance of wild thyme



Source: our elaboration on Eurostat data (2020)

Between 2007 and 2019, main EU importers of wild thyme were Spain (30% of the total EU import) and

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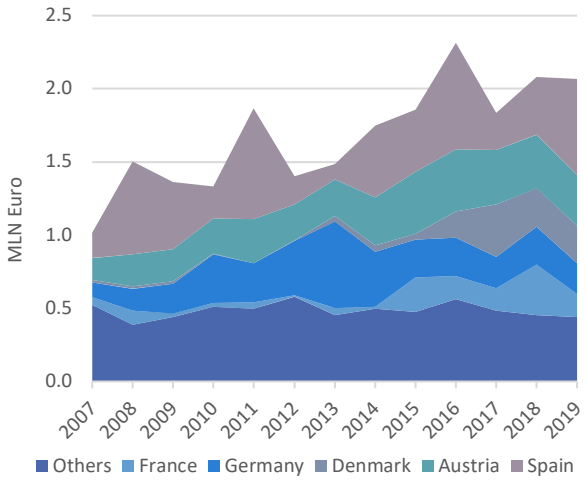
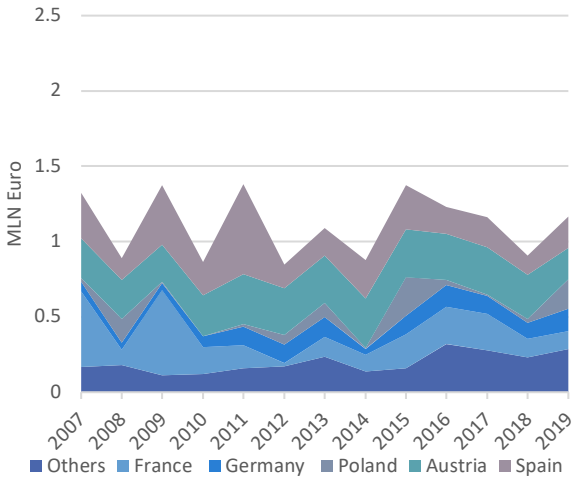
Austria (17% of the total EU import). In the same period, these two countries have more than doubled their import of wild thyme (Figure 16). In 2019, the same countries represented also the top EU exporters of wild thyme, but unlike the import, between 2007 and 2019, the value of their export of wild thyme has been quite stable (Figure 17).

Figure 16: EU27 import of wild thyme



Source: our elaboration on Eurostat data (2020)

Figure 17: EU27 export of wild thyme



Source: our elaboration on Eurostat data (2020)

3.6. The role of Tunisia and Algeria in the export of analyzed products

Focusing on the trade flows of the five products considered between Tunisia and Algeria, it's evident how the five products considered in the research cover a very marginal role in the relation between these two countries and Europe. However, from a detailed analysis of Eurostat data it is possible to find out that:

- In recent years there has been a commercial flow of pine nuts between Tunisia and the EU-27. The only European destination for pine nuts exported from Tunisia is Italy and, in 2019, the value of this flow reached 0.25 M€. Until 2016, Algeria was also a supplier of pine nuts to Italy, with a value of 0.1 M€, but, in the recent years, these flows have been strongly reduced to the point of disappearing.
- The only destination of thyme from Tunisia is France. This flow has only been recorded in the last three years, and in 2019, the value of this trade flow was around 0.2 M€. In 2019, there was also a commercial flow of bay leaves between Tunisia and France (around 90,000 Euros). As already observed for the thyme, also for the bay leaves, the only European destination of bay leaves from Tunisia is France.
- On the other hand, there are no commercial flows between Tunisia, Algeria and the EU-27 for fresh and transformed truffles.

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4. The concept of supply chain on wild food provision

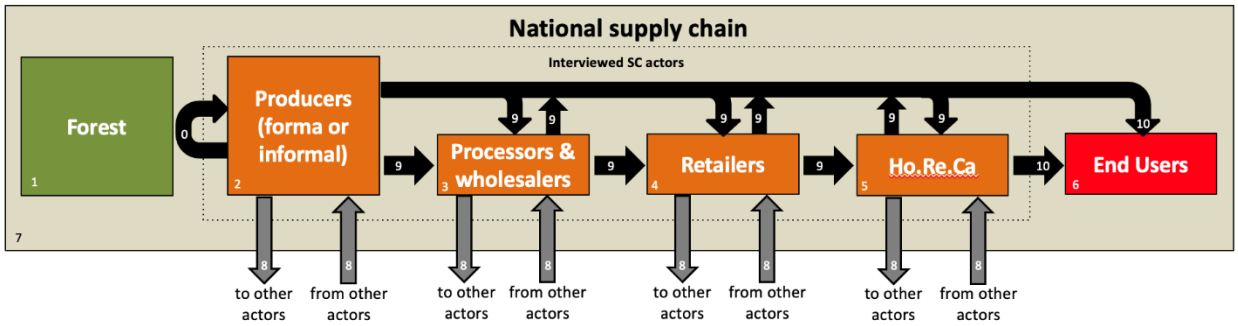
The chapter is divided in two parts. The first introduces the concept of supply chain and how national authorities' collect data along the supply chain. The second part summarizes the description of the supply chain of the target wild foods.

4.1. Wild food supply chain: the origin of the national statistics

Data are always important for any economic review, and often the comparability of results on different studies applied to the same economic phenomena may provide very diverse outputs. For example, forest Europe (2020) reported a value of 4 billion Euro generated by non-wood forest products for the year 2015, but, for the same year, a different study proposed by Lovrić et al. (2020) suggested a value of 23.3 billion Euro as total economic value generated by wild harvesting in Europe. This last data considers both the value of wild products used for home consumption, as well as the wild products sold as source of income, in which the market value is approximately 3.5 billion euro for the sole non-animal food collected in the forest and ornamental plants. Hence, if we remove the value of Christmas tree from the estimation of Forest Europe (2020), the value decreases between 2.9 and 2.6 billion euro. The example is a single case of what can be found if we pay attention at the data in literature, and it gives an idea of the messy statistic beyond these products.

Data on production and value are collected in different ways along the supply chain of wild foods. Using a theoretical model of the wild food supply chain (Figure 18) we can describe the key points, in which quantitative or qualitative data are collected by the public authorities and then release as aggregated statistical data. **The first key point** is based on the harvesting rights (see Figure 18 arrow "0"). For certain wild foods, you need a harvesting license, and this occurs in several states, as well in all the project partner countries. In case the collection of wild plants takes place in private forests, some countries, like Spain and Portugal, let the forest owners issue the harvesting right directly to the picker (or producer), while, when the collection occurs in public land, the public authority releases the harvesting rights. The commercialization or the simple release of the harvesting rights is a sort of census of the pickers that can provide crucial information on the socio-economic dimension of the picker's population of a specific wild product or product category. **The second key point** is represented by the formal transactions among economic players and the commercialization of the wild product to the final users (see Figure 18 arrows "9" and "10"). The transactions have two types of direct and indirect taxation (i.e. VAT), in which this last is applied for each commodity, according to the commodity classification adopted for the international trade (combine nomenclature or harmonized system codification)[6]. **The third point** is represented by the transactions that cross the national border (see Figure 18 arrows "8"). The commodities, which are sold outside the national border or purchase from companies in foreign countries, are eligible for customs duties according to the custom commodity classification just mentioned for indirect taxes. The third point is the most reliable in terms of data quality, due to the need of the custom agency to apply the custom duties to the commodities.

Figure 18: Theoretical supply chain



Note: the economic actors in red box will not be analyzed for developing D1.2 and D1.3. 1: forest; 2: producers of wild foods both formal (formal company) or informal activity; 3: processors and wholesaler; 4: retailers; 5: hotels, restaurants and catering; 6: end users like privates that purchased wild food, as well restaurant clients; 7: national boundaries; 0: harvesting activity; 8: commercialization of wild food from or to other countries; 9: transaction among economic actors inside the national boundaries; 10: commercialization of wild foods to the end user.

[6] See Directive EU 112/2006.

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Almost all of official statistical data on the production and trade of wild foods comes from one of the three mechanisms just explained. Nonetheless, almost no data are available along the supply chain, so only a direct data collection can provide information to understand the structure and policy implication of specific policies applied to wild foods. An example has been provided by Vidale, et al., (2015), that described the structure and dimension of a set of wild forest products in different European countries. The results of their research highlighted the needs to design a correct stakeholder engagement[7] based on a representation of the different actors involved in the chain, as well as the meaningful use of the results, whether compared to the policies applied to each single supply chain. Among the key indicators used to design policy advise, the most useful was the price evolution along the chain, that will be the target analysis on the data we will collect on the target wild food indicated in Table 2[8].

Focusing on the analysis of the properties of the single supply chains, the business models can vary greatly, depending on the type and the origin of the product (Wolfslehner et al., 2019). The final market is crucial to shape the structure of the supply chain and it depends on the commercial characteristics of the products. For instance, supply chains devoted to the provision of mass market products (i.e. pine nuts) tends to have more proportional redistribution of the added value, while product destined to a niche market (i.e. truffles) has often an unstructured supply chain due to the speculative dimension of the market (Amici et al., 2019). Consumers have different role in the supply chain: from no involvement (i.e. mass markets of goods), to indirect involvement (e.g. territorial and niche products), direct involvement (e.g. experiential products), and personal collection (e.g. personal consumption) (Meinhold & Darr, 2020). Each of these economic behaviors tends to move the high revenues of the product value added closed to the "involved" consumer, which enhances its willingness to spend. In general, wild products collected from non-professional pickers have larger price share compared to the same product produced in specialized plantations, due to the lower cost of the wild picking. In general, for wild foods ready to use, product grown in specialized plantation flows into short value chains, in order to avoid middlemen, while product obtained from wild harvesting relay on middlemen who commercialize large quantity and creates its business on the market knowledge asymmetry (Moore, et al., 2012). All these aspects of the supply chain structure will be tackled in deliverable 1.3.

4.2. A general overview of the existing supply chain on wild food

The paragraph report briefly the main references on the supply chain of the target products in order to provide a general overview of the existing knowledge regarding their structure and performances.

4.2.1. Supply chain of medicinal and aromatic plants

Medicinal and Aromatic Plants (MAP) category includes four of the target products such as rosemary, lentisk, myrtle and pennyroyal. MAP trade has been characterized by growing interest worldwide in recent years, and this trend requires higher product quality and reliability of supply (Argyropoulos, 2019). Despite this trend, in their upstream basis, MAP supply chains are still characterized by informal supplier of the raw material[9], which are located mainly in southern and eastern European countries (i.e. Bulgaria, Turkey and Portugal), as well north Africa (i.e. Tunisia and Algeria). While some plants or their extracts are sourced from cultivated, still a large part of aromatic plants are harvested in the wild, which leads to a dominant role of processors in the market. In other words, there is a price-based market with highly competitive tendency in the first sections of the supply chain, and few large companies that process the raw material into final products (Argyropoulos, 2019). Probably, we will have similar type of supply chain structure for rosemary, lentisk and myrtle. This last is used in Europe to produce jams and liquor and the processors still prefer to use only wild myrtle berries for price reason and also for the absence of cultivar with special characteristic. This fact makes the current market demand for cultivated myrtle very scarce. Franco et al. (2019) highlighted the potential interest in myrtle applications other than the jam and liquor industry as incentive for a different domestication of myrtle in order to increase productivity and specificity of the cropped myrtle. A similar trend has already been observed for Rosemary (*Rosmarinus officinalis*), that represents a very popular culinary herb, especially in Mediterranean foods. The recent growing interest in the medical use of rosemary

[7] Stakeholder engagement will be reported in deliverable 1.2

[8] Supply chain analysis will be report in deliverable 1.3

[9] Informal pickers are commercial supplier of wild foods or other wild products that collect without

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oil has contributed to the emergence of concerns of uncontrolled collection (González-Minero, et al., 2020), which may contribute to a decline in the natural population (Carrubba, et al., 2020). Also the supply chains of pennyroyal and lentisk have similar properties, where the pickers are mainly informal or self-employed workers, often organized in cooperatives, or linked to private companies (Brenko, et al., 2019). In the case of lentisk, historically, its oil has been used mainly for lighting, the medical treatment of wounds and as a food (Lanfranchi, et al., 1999). In recent years there has been a growing interest in lentisk, with the introduction of numerous commercial brands. However, these trademarks do not rely on specific regulations to ensure safe use as an edible or cosmetical products (Benalia, et al., 2021). In the case of pennyroyal, which represents one of the four commercially most important *Mentha* species, it is very abundant in the Iberian Peninsula and in North African countries, and examples of cultivation of this plant are very rare and most of the supply chains are based solely on the informal market. Pennyroyal is sold dried mainly directly to the end user or through reseller that put the mint in teabags.

4.2.2. Supply chain of acorns

The acorns have grabbed an increasing attractiveness as it is considered an alternative source of food both for livestock and for human consumption. Historically, for centuries, this product had been widespread in the cuisine of many nations, countries and cultures (Tantray, et al., 2017), but in recent decades, acorns had almost disappeared as a food product or even as an ingredient and are mostly more associated with animal nutrition mainly in Spain, South Italy and Portugal. In recent years the acorn, in the form of oil or cream, has been reintroduced in sweets and bread of Mediterranean cuisine (Szabłowska & Tańska, 2021). Since the oak represents one of the most abundant hardwoods in the world and the acorn was one of the key elements of our ancestors, the domestication of acorns began a long time ago in many and different countries of the world. The actual production of acorns for food is very scarce and the management of the oak forest for the production of acorns is mainly associated with other services. For example, high-quality Iberian ham, to be certified as such, requires pigs to eat about 10 kg of acorns per day (Lopez-Bote et al., 2000). The southern Mediterranean countries still use acorns as pig feed and the provision is mainly self-sourced by local farmers that collect acorns in forest. In some rare case, there are companies that collects acorns for selling, but they are almost disappearing due to the high costs of acorn collection.

4.2.3. Supply chain of pine nuts

Pine nut can be considered both a wild nut or a cropped product according to the way pine nuts are produced. Pine nuts supply chain is quite dynamic due to its global dimension. For decades, the retail price of shelled pine nuts has been the highest among cropped and wild nuts, which help to search alternative supply from the stone pine seeds (*Pinus pinea*). This fact has motivated a positive attention to the management developed with the aim of increasing the production of pine nuts and the profitability of forest land. It is not uncommon, that forest owners of pine stone forest get higher profits from nuts than from timber, moving from a forest management plan oriented to maximize the annual profit generate by pine nut production (Mutke, et al., 2011). The high demand for pine nuts contributes to formalize the collector within well-structured organization. Unlike other wild forest products, informal collection of pine nuts is organized in remote and less accessible areas, often totally carried out illegally, and destined for export (Mutke et al. 2019). In recent years, the production of pine nuts in Mediterranean Europe has been negatively affected by the spread of *Diplodia sapinea*, a fungus associated with an insect (*Leptoglossus occidentalis*), which acts as a fungal vector. The impacts of the pest had a devastating impact on forest management, production and profitability and therefore in the organization of the value chain, with strong effect in the international market. The reduced availability of European production on the markets, and the continuously growing demand, has stimulated the import of pine nuts mainly from Russia, China and Korea (Awan & Pettenella, 2017), as confirmed in the previous chapter, where we found that China has become by far a leading exporter of pine nuts. Another niche product is represented by Aleppo pine seeds, which are used to extract oil as food or cosmetic ingredient. Today there are basically no information on the actual state of the supply chain, even though the most common suppliers are represented by Turkey, Tunisia and Algeria.

4.2.4. Supply chain of truffles

Finally, truffles supply chain is considered the most profitable Mediterranean wild forest product with a high potential on market expansion at global scale. Truffle supply chain relays both on wild harvesting and

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cultivation for all the traded species. Among all traded species, the supply of wild black truffle has been substituted with the cultivated one, in a sort of semi-wild production in specialized orchards, where Spain in few years has become the global leader. The high profitability of black truffle cultivation triggered the development of the first part of the supply chain, which also includes other types of actors, such as consultancy and services, in addition to the truffle dog (Brenko et al., 2019). On the other hand, summer truffle is mainly harvested in the wild where Italy has a leading position in the market, even though it is constrained by the informal harvesting, which does not allow the company to formalize the transaction for the proof of the origin. This odd situation let the formal supply chain to collapse, with an increment of raw material importation. According to MIPAAF (2018), the Italian production can range between 400 and 480 tons of summer truffle, but less than one-third was declared in 2015. The high diffusion of informal collectors is not only an Italian problem, but it represents the majority of European production, which lead to an opportunistic market, where the truffle price is determined only from the seasonal availability. The increment of the control in certain countries pushes informal picker to become small legal business activity in order to sell their products. The recent reshape of the taxation system in Italy has enhanced the formalization of the transaction but it is still on an implementation phase. According to Martinez de Arano, et al. (2021), it appears urgent to adapt the process undertaken in Italy to other European countries in order to uncover a promising forest asset that needs to be boosted in order to reduce the risks of new international competitors like Turkey, Iran, Armenia and Azerbaijan. Other interesting truffle species are represented by the so-called desert truffles, represented by the species of the genus *Terfezia spp.* and *Tirmania spp*. which form mycorrhizal associations mainly on roots of various species of the genus *Helianthemum*. These truffles are mainly traded in northern Africa, Arabic peninsula and central Asia, where the uses of these species are linked to the cultural and religious habits of the wealthy and noble population. Today the Arab peninsula countries are the main buyers while Tunisia, Algeria and Morocco are considered the main exporters even though there are no formal statistics on production and trade.

4.3. Economic players and activities along the supply chain of target wild foods

Wild foods are generally collected or produced in forest and then transfer to the final user through a supply chain, which can be simple or very articulated. The added value creation is a combination of several factors that characterize each supply chain in its actions to transfer the product from forest to the end users; hence there can be different supply chains for the same product, which generate different added values. Each action has a cost that increase the price of the product and the transformations of the product are generally the phase where higher added value is created. However, it is not a rule, because wild food supply chain area also characterized by a high asymmetry of the market knowledge, where the price increment can be much higher than any transformation process. The paragraph describes synthetically the main activities carried out by the economic players of the supply chains dealing with the key wild food products.

4.3.1. Activities on pine nuts supply chain

Pine nuts market is built over several supply chains that can operate both at local and international level. The supply chain starts from the collection of pine cones in forest or the production of cone in farmland, both in specialized orchards or parcels of forests inside the farmland. The cones are collected and put to dry at the sunlight, until the cone release the seeds. Usually, the pickers sell directly the cones to the wholesalers that carry out seed extraction, but it is generally linked to the dimension of the producers, where the small one sell directly the daily or weekly harvest, while the large pickers sell them with or without shell. The primary wholesalers are a key player for the concertation and trading cone or un-shelled seeds, which are usually sold to the processors that carry out the shelling or husking activities as well as the activates that allow the product to be sold to the companies dealing with the end users like retailers and Ho.Re.Ca. A recent tendency is linked to the role covered by the farm activities. Farmers has commuted its role inside the supply chain grabbing the activities that were historically carried out by processors and wholesalers, and sometime also by retailers. This is due to the lower taxation imposed to farmer compared to traditional commercial activities. The phenomenon occurs mainly in the European countries, while role of the economic players involved in the pine nuts supply chain has remain stable in Northern African Countries. The subsidies system implemented in Europe helped the European farmer to improve their role in the supply chain, especially in Spain, Portugal and, partially, in Italy.

The pine nuts supply chain is characterized by transformation effect from cone to shelled pine seed that

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decrease the traded volume and increase the price per sold unit. In other words, from 22-28 kg of pine cones, we can obtain 1 kg of shelled pine seeds, which means that nearly 4% of the total weight of traded cone is transformed into nuts. The transformation factor can dramatically change according to the pine species, hence these values are referred to the European stone pine. According to scientific and grey literature, the price of fresh cone range between 0.55€/kg up to 1.2€/kg according to the local market labour cost and transformation factors into pine seeds, which mean a price of 14-28€/kg for the pine seeds at wholesaling level. The final price really depends on packaging cost, which can push the price up to 85-100€/kg for the 20 g packages. Due to the lack of information on data, a deeper analysis on the pine nuts price along the supply chain will be reported in the Deliverable 1.3. A summary of the description of the main activities is reported in Table 6.

Table 6: Activities carried out along the pine nut supply chain

	Producers			Wholesalers				Retailers	
Activities on pine nuts supply chain	Non-professional pickers	Professional pickers	Farmers	Primary wholesalers	Other wholesalers	Distributor	Processors	Retailers	Ho.Re.Ca. - Hotels Restaurants - Catering
Collection in wild	■	■							
Cultivation			■						
Cone cleaning	■	■	■	■					
Cone storing			■	■					
Cone drying	■	■	■	■					
Seed extraction	■	■	■	■					
Seed de-husk/shelling	■	■	■	■					
Seed grinding/sorting	■	■	■	■					
Seed storing		■	■	■	■				
Packing for retailing fresh products		■	■	■	■				
Packing for wholesaling		■	■	■	■				
Trading		■	■	■	■	■			
Drying		■	■	■	■	■			
Freezing		■	■	■	■	■	■		
Cooking		■	■				■		
Oil extraction		■	■				■		
Canning		■	■				■		
Packing for final consumers		■	■				■	■	

Source: authors elaboration.

4.3.2. Activities on truffle supply chain

Truffle supply chain is a wide concept that refer to the companies and non-professional actors involved from the production to the commercialization of truffles and truffle products at the end user. The most common traded truffle is the summer truffle, which can be collected from western Europe to central Asia, and from north Africa to Scandinavia. The local supply chain is very simple, and it is often formed by two actors, the non-professional picker and the restaurant, or even the restaurant alone which organizes truffle collection with internal personal. Professional pickers are much less common than non-professional ones, due to the discouraging taxation system applied to the professional collectors of wild foods. In the last two decades, farmer increased in number and value created, and in certain countries they became main providers of fresh truffle. It is the case of Spain, which is the main global producer of black truffle, followed by France and Italy,

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where the last one still relays on wild production. The activities are quite simple in the fresh truffle market, where picker and wholesalers are mainly involved in sorting, cleaning and trading with restaurants. On the contrary, the transformation is carried out by processors that transform the truffle into creams and sauces for retail distribution. The price of summer truffle is quite low compared to the other truffles, and a non-professional picker may receive between 25 and 60 €/kg in western Europe, or 18-45€/kg in eastern Europe, and about the same from other international suppliers. The wholesalers increase generally by 30-100% the price for the domestic market and between 120 and 200% in case the product is re-sold abroad. The restaurant finally can easily double the wholesaling price to the end user according to the recipe used. An important issue is the weight loss along the chain, which can impact very much on the final price of the product especially for the products commercialized during the fall, period in which the loss of weight and raw material costs are higher compared to the summer. A synthesis of the activities carried out along the summer truffle supply chain is reported in Table 7.

Table 7: Activities carried out along the summer truffle supply chain

	Producers			**Wholesalers**				**Retailers**	
Activities on truffle supply chain	Non-professional pickers	Professional pickers	Farmers	Primary wholesalers	Other wholesalers	Distributor	Processors	Retailers	Hotels Restaurants - Catering
Collection in wild	■	■							
Cultivation			■						
Storing	■	■	■	■	■	■	■		
Grinding/Sorting	■	■	■	■	■				
Cleaning	■	■	■	■	■		■		
Packing for retailing fresh products		■	■	■	■	■		■	
Packing for wholesaling		■	■	■	■	■			
Trading		■	■	■	■	■		■	
Drying		■	■	■	■	■	■		
Freezing		■	■	■	■	■	■		
Cooking		■	■				■		
Canning		■	■				■		
Packing for final consumers		■	■				■	■	

Source: authors elaboration.

4.3.3. Activities on medicinal and aromatic plants supply chain

The aromatic plants, which represent the wider group of species traded at global scale. The wild collection represents a smaller part compare to the farm production, and this is due to the increase of demand and productivity of the specialized production. The aromatic plants are generally sold fresh or dried, depending to the type of final use. The main production is located in south east Europe and north Africa, where the production is collected and naturally dried before entering in the market. The process is carried out directly by the farmers or local processors, while the wholesaler transfers it to the main reference market, such as central and northern European countries. Due to the high number of species, it is quite complex to describe the value added from producer to the end user, which will tentatively study in the Deliverable 1.3 for lentisk and myrtle. Lentisk is used to extract oil for food and cosmetic use, and it is collected mainly by pastors and pickers in small quantities, then concentrate at wholesaling or processing unit. The lentisk oil is extract similarly to olive oil process and it is used as ingredient for cosmetic product or used as cooking oil in rural area, despite its bitter and strong taste. Myrtle is collected in the same environment of lentisk, which is the

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Mediterranean bush, and it is mainly used as an ingredient for tea infusions, jams and liquors. The collection occurs in late autumn and winter. Either for lentisk and for myrtle, the market information is very limited and only through a direct data collection along the supply chain, we could have an overview of the price evolution along the chain. Finally, the pennyroyal mint is collected as ingredient for tea infusion, after a process of dehydration. Again, the information is very limited regarding price and structure of the supply chain. A synthesis of the activities carried out along the aromatic plant supply chain is reported in Table 8.

Table 8: Activities carried out along the aromatic plant supply chain

	Producers			Wholesalers				Retailers	
Activities on aromatic plant supply chain	Not professional pickers	Professional pickers	Farmers	Primary Wholesalers	Other wholesalers	Distributor	Processors	Retailers	Hotels Restaurants - Catering
Collection in wild	■	■							
Cultivation			■						
Plant cleaning	■	■	■	■					
Drying			■				■		
Storing			■	■			■		
Grinding/Sorting	■	■	■	■					
Packing for retailing fresh products		■	■	■	■				
Packing for wholesaling		■	■	■	■				
Trading		■	■	■	■	■			
Packing for end user		■	■	■	■	■	■	■	

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5. Taxes apply to the collection of wild foods: an overview among the project partner countries

Taxation is among the less studied topics in the forest sector. This is due to the complexity of the taxation system applied to each single species applied to a given country. As mentioned in chapter 4, taxation is a data gateway for many national statistics, hence the understating of the taxation mechanism applied to each economic actor of the supply chain become strategic to tackle the informal market and improve product traceability along the supply chain.

Informal supply of raw materials is a serious problem for companies, especially if their products are sold in the international market. This is due to the traceability chain that is often used as proof of the origin of the raw material. The informal suppliers or pickers are often reluctant to sign any formal invoice, declaration or bill proving the formal origin. FAO (1999), already 20 years ago, supported the idea to reduce as much as possible the taxation on "small" pickers, for two reasons: ensuring the possibility to have additional income source for local dwellers, as well as for ensuring the company to process the raw material and attract capital inside the rural economy. Wherever occasional commercial pickers are taxed with ordinary tax regime, they tend to sell their products informally in the grey market; this is due to the potential incompatibility of occasional, or semi-professional picking activities with receiving social subsidies (e.g. retirement pensions, unemployment payments), or other employment contracts (e.g. permanent public or private employees, police labour force contract, etc.). Nevertheless, without these suppliers, many wild products would not enter the market, as picking or harvesting activities are rooted in the local culture of forest use. Grey markets also pose serious problems with regard to product quality guarantees, in the case of food NWFPs, and ensuring adequate working conditions and the professional capacity of the workforce.

5.1. A review of the more efficient taxation regime applied to wild food in Europe

Fiscal, and labour regimes are generally not well adapted to wild food production carried out by non-professional pickers, and in particular to the seasonal and complementary nature of wild harvesting incomes. This lack of coordination between labour policies and tax regulation should be studied in deep in order to push a formalization of the raw material inside the supply chain. The most crucial point of any taxation regime is simply the definition of the different actors included in the supply chain. It is necessary to understand who is actually considered the wild food 'producer', defining the conditions that apply in terms of labour and tax regimes. In fact, a clarity on labour and fiscal regimes that producers (pickers of wild products, farmers, or a combination of the two typologies) must comply could contribute their entrance into the formal, legal market. If reasonable in terms of tax burden and bureaucratic requirements, this sets the basis for traceability, consumer safety, and transparency in the wild food supply chains, regardless of the product is applied at.

There are two important cases that are worth to be mentioned. The first is the introduction of a general tax exemption regime in Finland. Tax exemption, together with light bureaucracy procedure, stimulates the formalization of the wild food market. This is the option selected in Finland, where the income received from selling wild food, (all the ones that do not grow physically on a living tree – i.e. wild mushrooms, berries, etc.), is not subject to income tax if it is generated as an occasional activity and the total volume of selling remains below the 10000 € per year[10]. This policy, together with the everyman's right regime applied to the majority of wild foods, allowed the development of a stable and formal supply chain, that was able to compete in international markets despite the higher prices. The second is the case of Italy, that implemented a mandatory registration of the picker linked with a tax exemption threshold. There are different types of pickers: the one collecting for household consumption; the occasional commercial pickers and the professional pickers, or in other terms the ones that have formally recorded business activity. This option has been adopted successfully in Italy for occasional pickers. The mechanism was implemented with the national Law n. 145/2018, which established a threshold for income tax exemption of €7000 per year for occasional wild food pickers (see Figure 19). Since its implementation, the number of formal transactions move from less than few dozens, to several hundred thousands. The use of on-line tools facilitated this

[10] Income Tax Law Art 89. Income received by a collector from the supply of these products of wild cones, berries and mushrooms and wild plants or parts thereof collected for human consumption, medicine or the manufacture of a medicinal product shall not be taxable income unless the income is regarded as remuneration.

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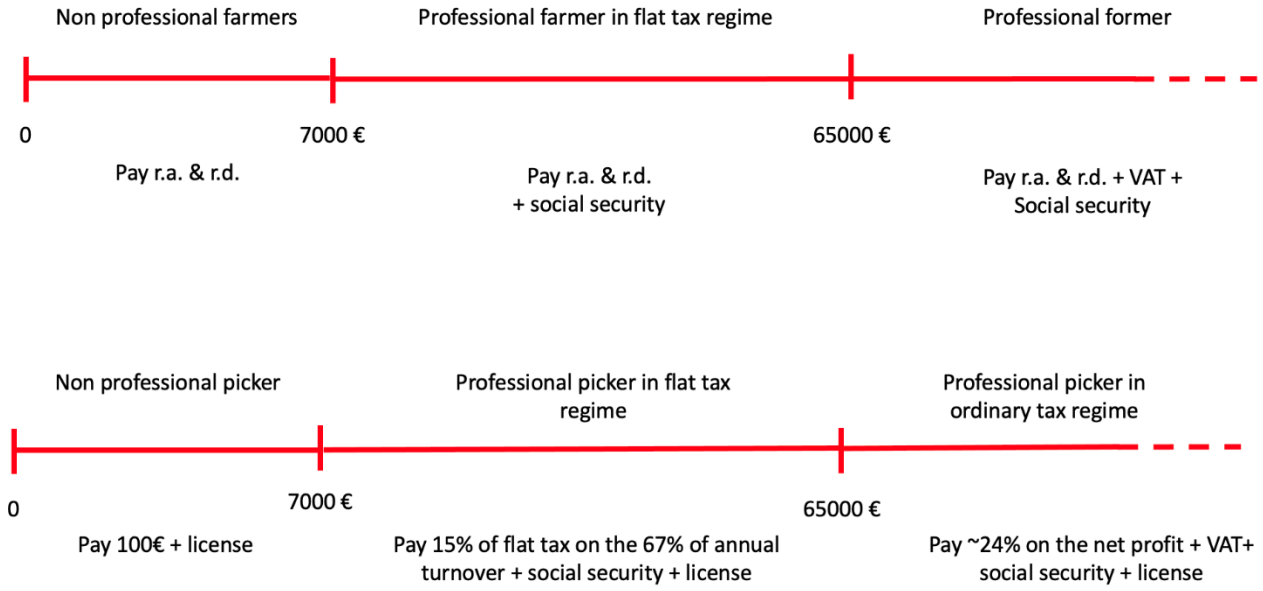
success, and this option seems very promising not only for the improvement of the traceability, but also to monitor the market almost in real-time.

Figure 19: Taxation regime applied to wild food producers in Italy.



A tentative to describe the taxation regimes applied in the countries participating at the project will be report in Deliverable 1.3.

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6. Bibliography

Amici, A., Beljan, K., Coletta, A., Corradini, G., Dănilă, I. C., Da Re, R., … Zivojinovic, I. (2019). Economics, marketing and policies of NWFP. In H. Vacik, M. Hale, H. Spieker, D. Pettenella, & M. Tomé (Eds.), *Non-Wood Forest Products in Europe. Ecology and Management of mushrooms, tree products, understory plants and animal products* (1st ed., pp. 125–200). Norderstedt, Germany: German National Bibliography.

Argyropoulos, D. (2019). *Plant-based medicinal and cosmetic products*. Bruxelles: EIP-AGRI.

Awan, H. U. M., & Pettenella, D. (2017). Pine nuts: A review of recent sanitary conditions and market development. *Forests*, *8*(10). https://doi.org/10.3390/f8100367

Benalia, Nabiha, Boumechhour, Abdenour, Ortiz, Sergio, Echague, Cristian A., Rose, Thorsten, Fiebich, Bernd L., … Boutefnouchet, Sabrina. (2021). Identification of alkylsalicylic acids in Lentisk oil (Pistacia lentiscus L.) and viability assay on Human Normal Dermal Fibroblasts. *OCL*, *28*, 22. https://doi.org/10.1051/ocl/2021009

Brenko, A., Buršić, D., Zgrablić, D., & Martínez de Arano, I. (2019). *A Road Map for innovating NWFPs value chains for the Aromatic and Medicinal Plants iNet*. Zagreb, Croatia.

Carrubba, A., Abbate, L., & Sarno, M. (2020). Characterization of Sicilian rosemary (Rosmarinus officinalis L.) germplasm through a multidisciplinary approach. *Planta*, *251*, 37.

FAO. (1999). Non-wood Forest Products and Income Generation. *Unasylva*, *198*, 1–77. Retrieved from http://www.fao.org/docrep/x2450E/x2450e00.htm#Contents

FAO EFI. (2015). *State of Europe's Forest 2015*. Retrieved from https://www.foresteurope.org/docs/fullsoef2015.pdf

Forest Europe. (2020). *State of Europe's forests 2020*. Bratislava, Slovak Republic.

Franco, A., Tocci, N., Guella, G., Dell'Agli, M., Sangiovanni, E., Prerenzoni, D., … Manca, G. (2019). Myrtle Seeds (Myrtus communis L.) as a Rich Source of the Bioactive Ellagitannins Oenothein B and Eugeniflorin D2. *ACS Omega*, *4*(14), 23–35.

González-Minero, F. J., Bravo-Díaz, L., & Ayala-Gómez, A. (2020). Rosmarinus officinalis L. (Rosemary): An Ancient Plant with Uses in Personal Healthcare and Cosmetics. *Cosmetics*, *7*(4), 77–81.

Kilchling, P., Hansmann, R., & Seeland, K. (2009). Demand for non-timber forest products: Surveys of urban consumers and sellers in Switzerland. *Forest Policy and Economics*, *11*(4), 294–300. https://doi.org/10.1016/j.forpol.2009.05.003

Lanfranchi, F., Bui, T.-M., & Girard, M. (1999). La fabrication d'huile de lentisque (Linsticu ou chessa) en Sardaigne. *Journal d'agriculture Traditionnelle et de Botanique Appliquée*, *41*(2), 81–100.

Lopez-Bote, C. L., Fructuoso, G., & Mateos, G. G. (2000). *Sistemas de producción porcina y calidad de la carne. El Cerdo Ibérico* (pp. 1–35). pp. 1–35. Badajoz, Spain: Asociacion Nacional de veterinarios de porcino iberico.

Lovrić, M., Da Re, R., Vidale, E., Prokofieva, I., Wong, J., Pettenella, D., … Mavsar, R. (2020). Non-wood forest products in Europe – A quantitative overview. *Forest Policy and Economics*, *116*(January). https://doi.org/10.1016/j.forpol.2020.102175

Lovrić, M., Da Re, R., Vidale, E., Prokofieva, I., Wong, J., Pettenella, D., … Mavsar, R. (2021). Collection and consumption of non-wood forest products in Europe. *Forestry: An International Journal of Forest Research*. https://doi.org/10.1093/forestry/cpab018

Martinez de Arano, I., Maltoni, S., Picardo, A., & Mutke, S. (2021). *Non-wood forest products for people , nature and the green economy . Policy priorities for Europe. A white paper based on lessons-learned from around the Mediterranean*. Barcelona, Spain.

Mayer, A. L., Kauppi, P. E., Angelstam, P. K., Zhang, Y., & Tikka, P. M. (2005). Importing Timber, Exporting Ecological Impact. *Science*, *308*(5720), 359–360. https://doi.org/10.1126/science.1109476

Meinhold, K., & Darr, D. (2020). The Processing of Non-Timber Forest Products through Small and Medium Enterprises. A Review of Enabling and Constraining Factors. *Forests*, *10*, 1026–1031.

MIPAAF. (2018). *Piano della Filiera Nazionale del Tartufo* (p. 42). p. 42. Rome, Italy.

Moore, S. E., Cubbage, F., & Eicheldinger, C. (2012). Impacts of Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) Forest Certification in North America. *Journal of Forestry*, Vol. 110, pp. 79–88. Cambridge, UK: Traffic International.

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Muir, G. F., Sorrenti, S., Vantomme, P., Vidale, E., & Masiero, M. (2020). Into the wild: disentangling non-wood terms and definitions for improved forest statistics. *International Forestry Review*, *22*(1), 101–119.

Mutke, S., Pastor, A., & Picardo, A. (2011). Toward a Traceability of European Pine Nuts "from Forest to Fork." *International Meeting on Mediterranean Stone Pine for Agroforestry*, 105–109. Zaragoza, Spain: Options Méditerranéennes. Série A. Séminaires Méditerranéens: n. 105.

Pettenella, D., Vidale, E., Da Re, R., & Lovric, M. (2014). *NWFP in the international market: current situation and trends. Project deliverable D3.1. StarTree project (EU project 311919)*. Legnaro (Padova), Italy.

Secco, L., Pettenella, D., & Maso, D. (2009). "Net-system" models versus traditional models in NWFP marketing: The case of mushrooms. *Small-Scale Forestry*, *8*(3), 349–365. https://doi.org/10.1007/s11842-009-9088-0

Szabłowska, E., & Tańska, M. (2021). Acorn flour properties depending on the production method and laboratory baking test results: A review. *Comprehensive Reviews in Food Science and Food Safety*, *20*(1), 980–1008. https://doi.org/https://doi.org/10.1111/1541-4337.12683

Tantray, Y. R., Wani, M. S., & Hussain, A. (2017). Genus Quercus: An overview. *International Journal of Advanced Research in Science and Engineering*, *6*, 1880–1886.

UNECE-FAO. (2003). *State of Europe's Forests 2003*. Vienna, Austria.

UNECE FAO. (2011). *State of Europe's Forests 2011*.

Vantomme, P. (2003). Compiling statistics on Non-Wood Forest Products as policy and decision-making tools at the national level. *International Forestry Review*, *5*(2), 156–160. https://doi.org/10.1505/IFOR.5.2.156.17412

Vidale, E., Da Re, R., Corradini, G., & Pettenella, D. M. (2015). *The regional markets of NWFP: current situation and effect on SME. Project deliverable D3.2. StarTree project (EU project 311919)*. Legnaro (Padova), Italy.

Wolfslehner, B., Prokofieva, I., & Mavsar, R. (2019). Non-wood forest products in Europe: Seeing the forest around the trees. In *What Science Can Tell Us* (Vol. 10). Joensuu, Finland.

Zohary, D., Hopf, M., & Weiss, E. (2013). *Domestication of Plants in the Old World: The origin and spread of domesticated plants in Southwest Asia, Europe, and the Mediterranean Basin.* (Fourth Edi). Oxford, United Kingdom: Oxford University Press.

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7. ANNEX I – PART A

Annex I, in the first part, includes the trade balance of the main products, in terms of imports, for each of the EU countries involved in the WildFood project. Since the main document already analyzes the trade balance for pine nuts for Spain and the trade balance for fresh truffle for Italy, the annex considers fresh truffle for Spain and pine nuts for Italy, as products of their trade balance. All the figures reported are our elaboration on Eurostat data (2020).

Figure 20: Spanish fresh truffle trade balance

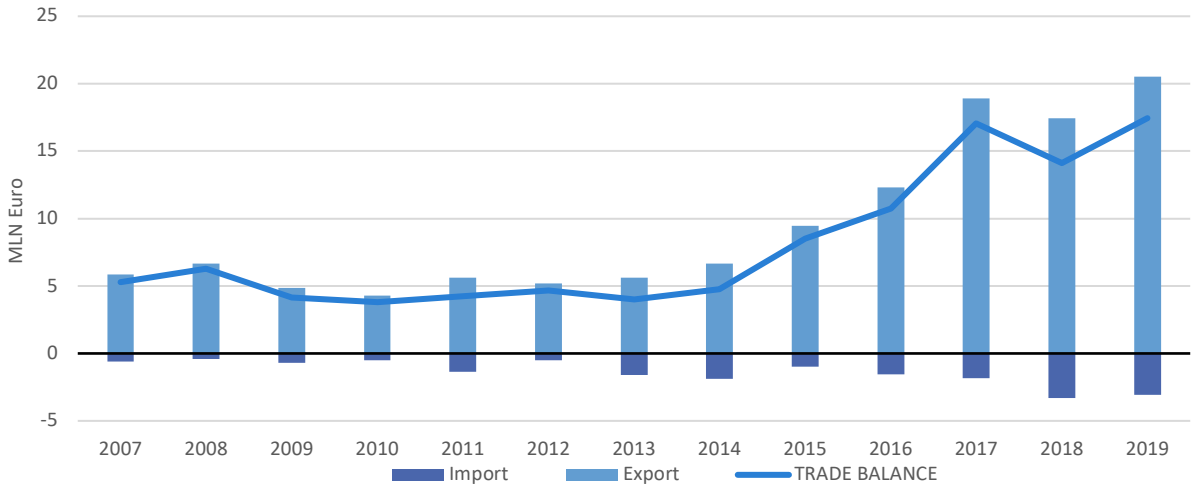

Figure 21: Italian pine nuts trade balance

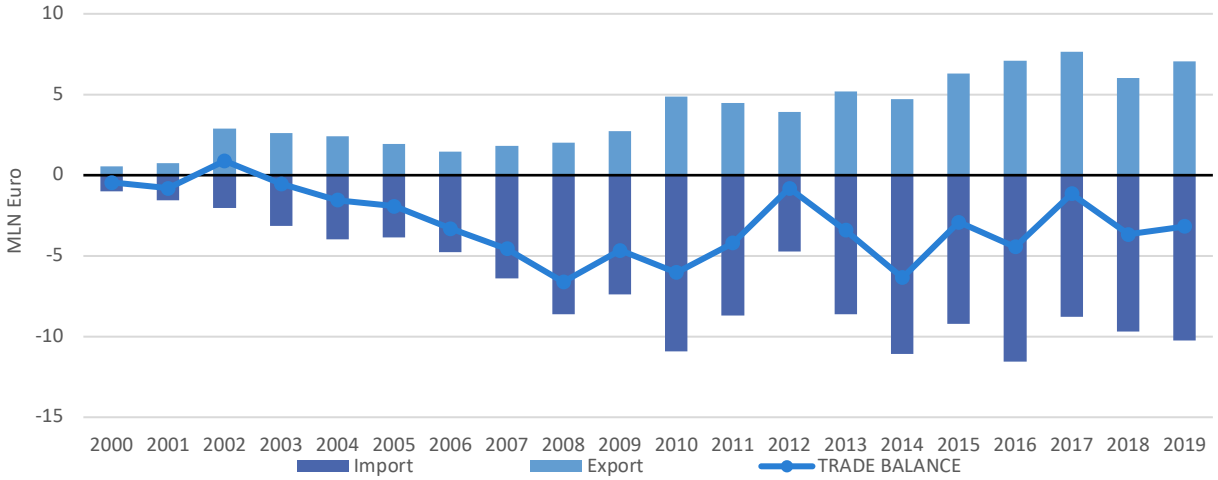

Figure 22: Slovenian fresh truffle trade balance

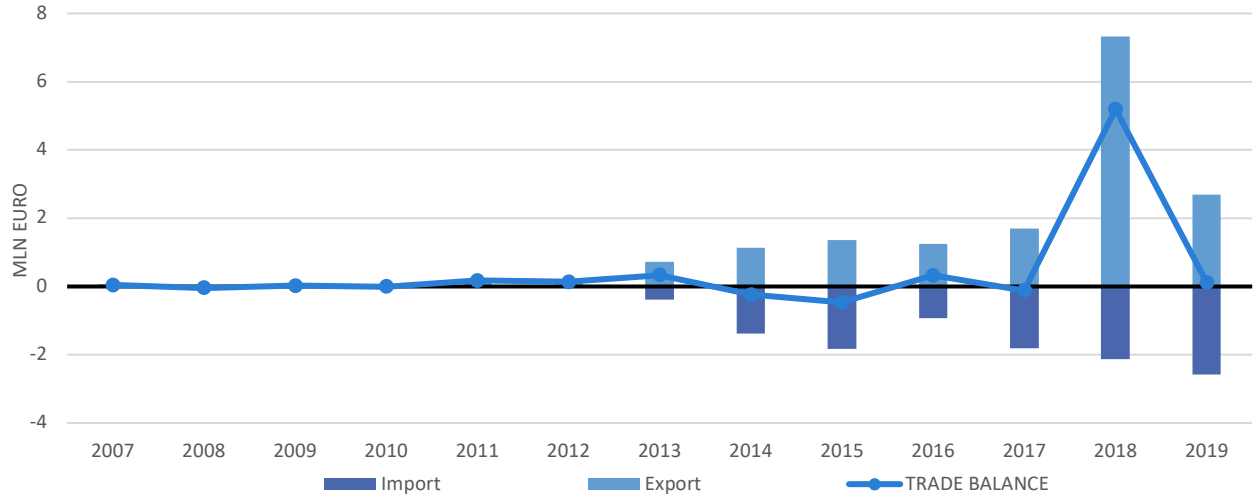

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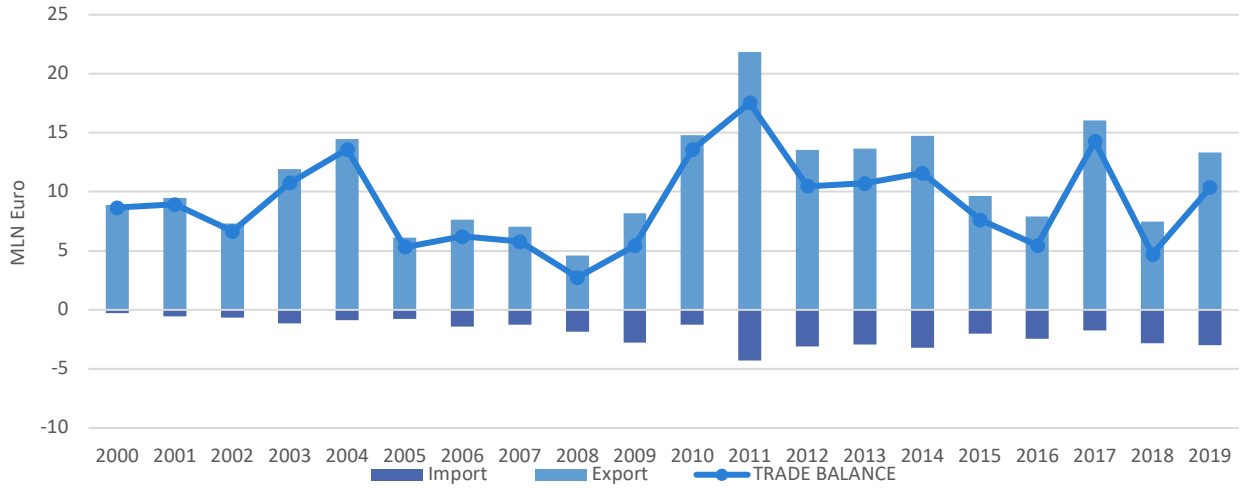
Figure 23: Portugal pine nuts trade balance



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ANNEX I – Part B

The second part of Annex I is dedicated to presenting the trend of EU-27 imports and exports from non-EU countries for: (i) fresh truffle, (ii) pine nut, (iii) wild thyme, (iv) bay leave and (v) prepared truffle, highlighting the role of the EU's top 5 partners.

Figure 24: Main partners of EU-27 for fresh truffle, in terms of import

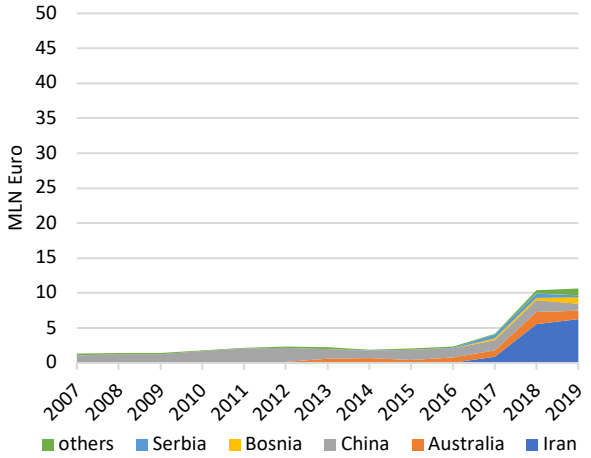

Figure 25: Main partners of EU-27 for fresh truffle, in terms of export

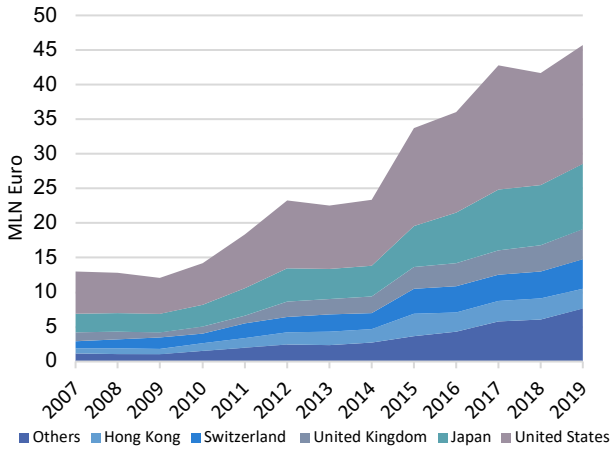

Figure 26: Main partners of EU-27 for pine nuts, in terms of import

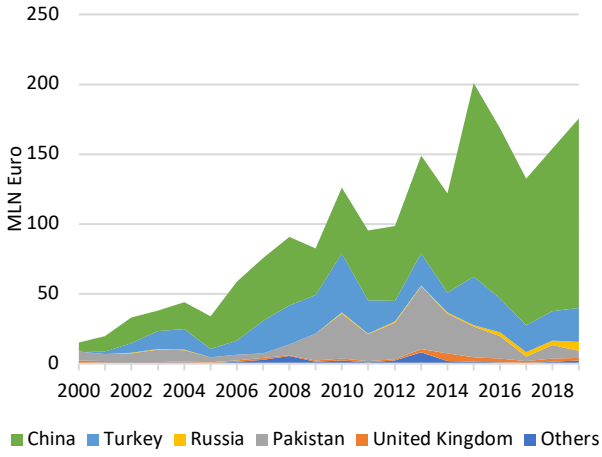

Figure 27: Main partners of EU-27 for pine nuts, in terms of export

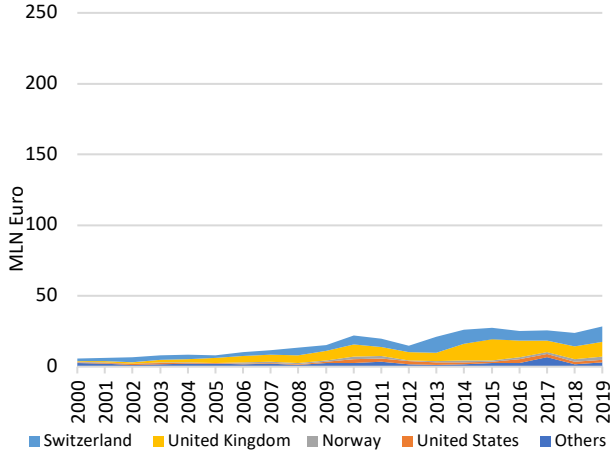

Figure 28: Main partners of EU-27 for wild thyme, in terms of import

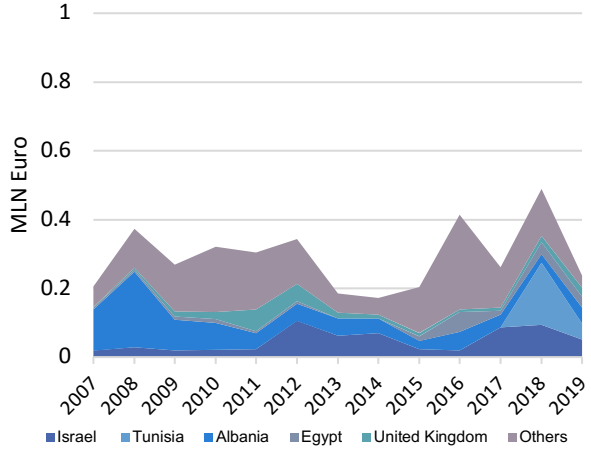

Figure 29: Main partners of EU-27 for wild thyme, in terms of export

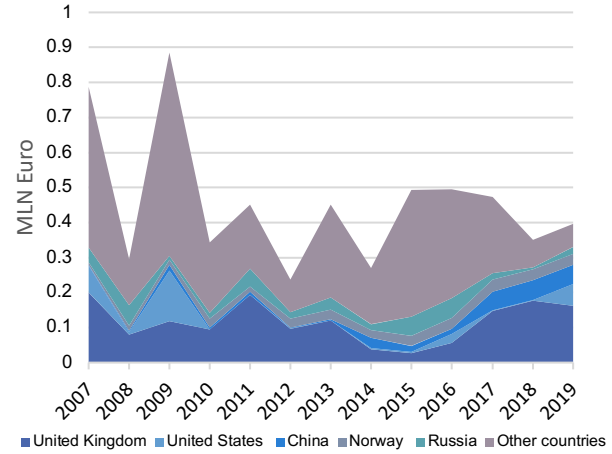

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Figure 30: Main partners of EU-27 for bay leaves, in terms of import

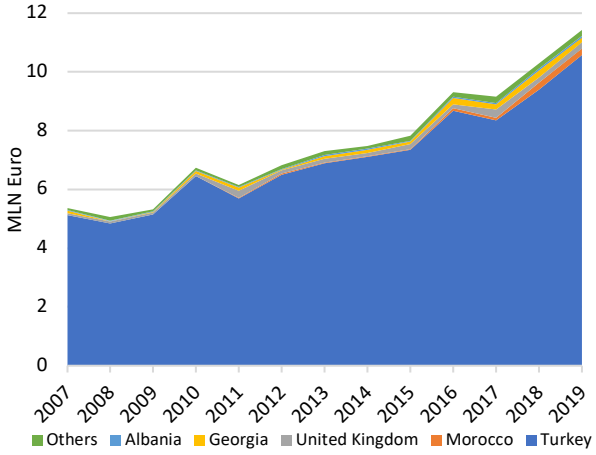


Figure 31: Main partners of EU-27 for bay leaves, in terms of export

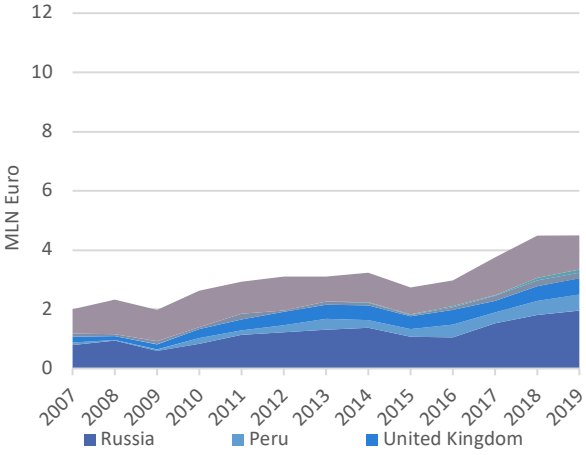


Figure 32: Main partners of EU-27 for prepared truffle, in terms of import

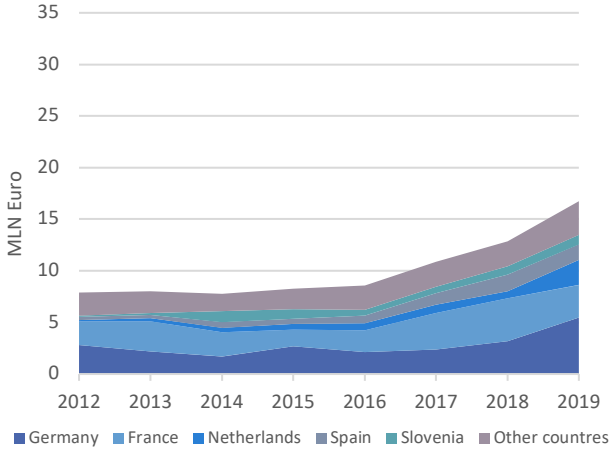
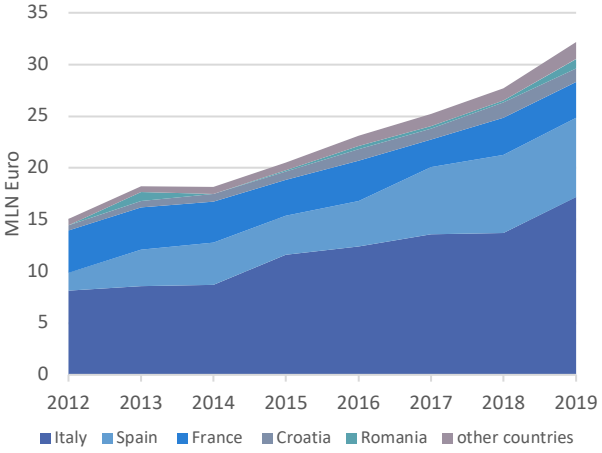


Figure 33: Main partners of EU-27 for prepared truffle, in terms of export



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