GUIDE TO APICULTURAL POTENTIAL, CLIMATE CONDITIONS, AIR AND SOIL QUALITY IN THE BLACK SEA BASIN

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Project: INCREASING THE TRADING AND MODERNIZATION OF THE BEEKEEPING AND THE CONNECTED SECTORS IN THE BLACK SEA BASIN ITM BEE-BSB

Regions: South-Eastern Romania
Severoiztochen Bulgaria
TR90 (Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane) Turkey
Moldova
Mykolaiv – Ukraine

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Black Sea CROSS BORDER COOPERATION

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WHAT IS THE BLACK SEA REGION?

Introduction

The Black Sea Region is made up of[1]:

- Romania: South-East
- Bulgaria: Severoiztochen, Yugoiztochen
- Greece: Kentriki Makedonia, Anatoliki Makedonia Thraki
- Turkey: TR10 (İstanbul), TR21 (Tekirdağ, Edirne, Kırklareli), TR42 (Kocaeli, Sakarya, Düzce, Bolu, Yalova), TR81 (Zonguldak, Karabük, Bartın), TR82 (Kastamonu, Çankırı, Sinop), TR83 (Samsun, Tokat, Çorum, Amasya) and TR90 (Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane)
- Ukraine: Odesa, Mykolaiv, Kherson, Zaporosh'ye and Donetsk Oblasts, Crimea Republic, Sevastopol
- Moldova, Georgia, Armenia: the whole country

Therefore, there are EU Member States (Bulgaria, Greece and Romania), partner countries (Armenia, Azerbaijan, Georgia, Republic of Moldova and Ukraine) and a candidate country (Turkey) (Figure 1.1).

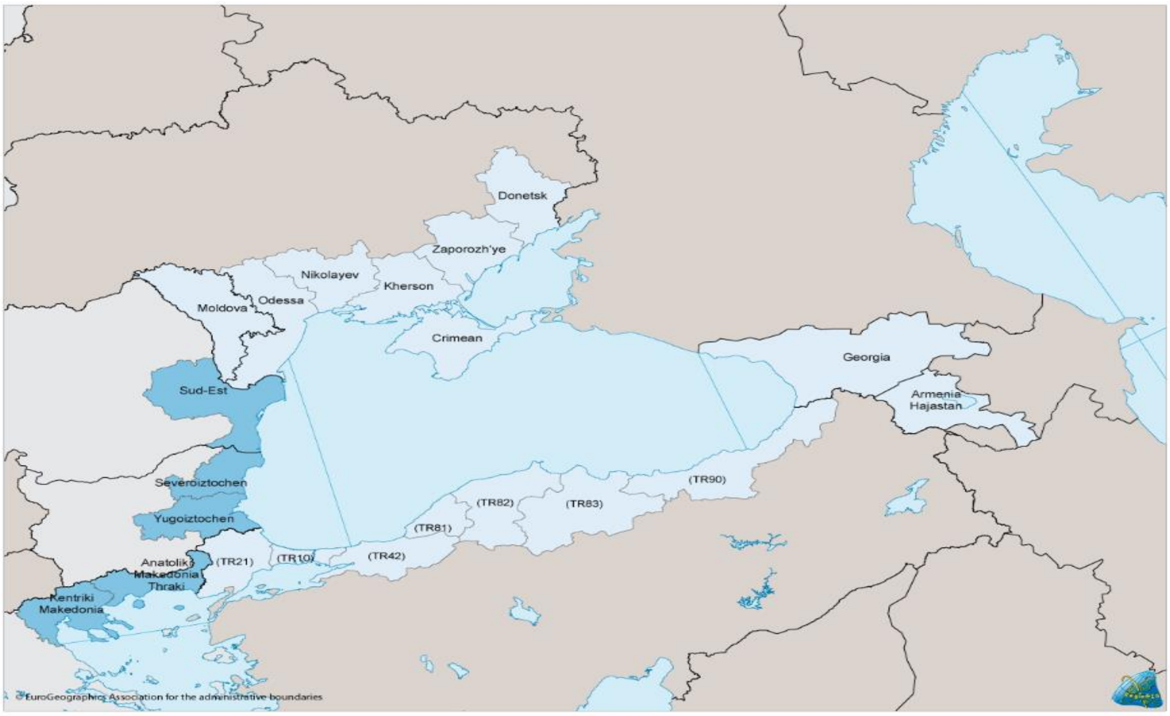

Figure 1.1: The Black Sea Region

Note: - EU regions cooperation areas in dark blue, other cooperation areas in pale blue[2]

[1] Joint Operation Programme Black Sea Basin 2014 - 2020

[2]Source: EC, DG Regional Policy: map of the ENPI CBC BSB 2007-13 programme - same regions included in the ENI CBC programme, format of the reference to the Turkish regions edited by the Managing Authority at the request of TK; References to regions from the Russian Federation and Azerbaijan were deleted as they have not confirmed their participation in the programme at the date of submission.

However, taking into account the partner institutions participating in the project "Increasing trading and modernization of beekeeping and connected sectors in the Black Sea Basin" ITM BEE-BSB, BSB136, co-financed by the Joint Operational Program Black Sea Basin 2014-2020, as for this paper, The Black Sea Basin region is restricted to their countries of origin, being made up of the following countries, including their basic regions, previously stated: Romania, Moldova, Ukraine, Bulgaria and Turkey.

Chapter 1 THE IMPORTANCE OF BEEKEEPING AT EUROPEAN LEVEL

The interest in beekeeping began in ancient times with the hunting of wild bee colonies and the collection of their honey from trees or rocks. With the improvement of sugar production technology in the nineteenth century, honey has been across time, the only food product used as a sweetener on a large scale. Bee honey has been appreciated not only as food, but also for its properties to be used in medicine.

People have researched and studied wild bees in order to obtain honey and facilitate its harvesting and collection. Thus, bee species designed for honey production have been developed. Wild bees have been permanently shrouded in an aura of mystery, due to their extremely social behavior and nature. Analogies have often been made between the social behavior of bees and that of humans.

Research on bees over time enables the modern beekeeper to apply economically viable and sustainable intensive production technologies and environmental resource management. Today's modern beekeeper can thus gather bee products from the hive with great ease and increased efficiency, a much higher efficacy than that of the honey hunter or gatherer.

Although, in time, people have learned a lot about bees based on their observations, about the ways to introduce them into intensive production systems, the bee is still a wild species with a very important role in the stability of ecosystems. Unlike most animal and plant species that have been introduced into intensive production systems in agriculture, the honey bee used today is the same as the wild bee thousands of years ago. Humans have failed to domesticate the wild bee. The honey bee, however, remained essentially a wild species. Humans have thus managed to introduce these wild bee species into intensive production systems, in order to obtain a much higher honey production, but so far, no control over the genetics of bee species and their behavior has succeeded to the same degree as and in the case of animal and plant species used in intensive agricultural production systems. That is why the term intensive beekeeping has a different meaning in relation to the other branches of production in agriculture and also a particularly important role in terms of links and relationships between the components of the ecosystem.

Initially, beekeeping developed as a specific hunting activity. Hunting of wild bee colonies was common in many parts of the world. This activity of collecting bee honey from these wild bee colonies was an occasional activity common to many farmers. This activity of collecting bee honey often occurs when trees in forests that shelter wild bee colonies are cut down during clearing operations, a precursor to the stripping of arable land for field crops. The hunting techniques used by honey gatherers are usually based on burning vegetation in order to kill bees. The honey thus obtained from these areas of destroyed vegetation was used for domestic consumption or was marketed in local markets. The quality of this honey obtained from wild colonies was very poor, because the honey thus obtained is mixed with brood and ash. In some geographical areas, bee honey is fermented either alone or with wine to obtain an alcoholic beverage. Bee honey is used in many regions as a medicine.

This hunting activity turns into an agricultural activity of handling bee colonies consisting in the farmer getting involved in the management of the bee colony in order to obtain regular harvests of honey and wax. Honeycombs containing bee honey are removed periodically and capitalized on the market, and those containing brood are left to maintain and develop the colony in order to obtain future harvests.

Thus, beekeeping has emerged as an activity that refers to the productive handling of a bee colony. Management practices in the field of early beekeeping imply relatively simple technologies, but as this branch of production develops, we encounter quite complicated procedures whereas equipment and technologies become more and more sophisticated. Beekeeping can be a profitable economic activity at any level of technology, but it is found that the level of production technology deployed should match the economic reality of local markets.

Honey production and consumption in the Member States of the European Union (EU) are indicators on the basis of which the EU is considered the second largest producer of bee products in the world and a major player in the beekeeping market. According to EUROSTAT data, EU bee honey production was around 250,000 tonnes in 2018, representing 13.3% of the global production. However, EU production has increased slightly over the last ten years (+ 6% compared to 2010), with negative or positive annual variations, depending on the climatic and meteorological conditions. The European honey production, according to statistics, covers only 60% of the annual needs of European consumers. According to EUROSTAT, the consumption of bee honey at European level represents approximately 20-25% of the world honey consumption, thus representing an average consumption of 0.70 kilograms per person per year. The EU is thus one of the largest importers of bee honey, with annual imports of bee honey ranging from 120,000 to 150,000 tonnes. The main suppliers of bee honey are China, with 63,900 tons (43% of total EU imports), Argentina, with 22,300 tons, Mexico, with 21,200 tons, and Ukraine, with 8,900 tons of honey. At the same time, the lower price of the bee products from China is a determining factor leading to a decrease in bee honey exports from EU Member States.

The support given to the European beekeeping in the recent years by the EU's common agricultural policy (CAP) has been represented by a number of policies, through which support programs and measures for beekeepers have been implemented. These common agricultural policy measures have taken into account a number of problems that the European beekeepers are frequently facing, namely the massive loss of bee colonies, rising production costs for bee honey and the fierce competition in beekeeping market.

The main objectives of all these programs and measures have been continuously improved through actions in the field of production technologies and marketing of bee products. It is worth mentioning a series of measures, such as: support programs including technical assistance (training courses), active measures to combat varroasis and also passive measures consisting of the rationalization of transhumance and support for the analysis of honey quality and the development of applied research in intensive beekeeping. The progress of economically viable and sustainable intensive beekeeping in terms of environmental resource management will thus contribute to increasing the quality and competitiveness of this beekeeping sector and also to the economic and social development of rural areas.

By means of pollination, the bee colonies ensure the balance in agricultural ecosystems and will continue to act as providers of important services for the conservation of environmental resources, thus ensuring a sustainable development of these rural areas.

Threats to bee health and increased competition in the market are factors that affect the economic viability and sustainability of beekeeping. EU policies aim to provide solutions to all these problems encountered by the beekeeping sector and seek to address these issues from a sustainability perspective that promotes the analysis and conservation of vital environmental resources.

Starting from ranking and the role of the European beekeeping, we find that Romania ranks second in the European Union, after Spain, when it comes to the number of hives of bee families and on the first position in terms of the bee honey production (Eurostat, 2018).

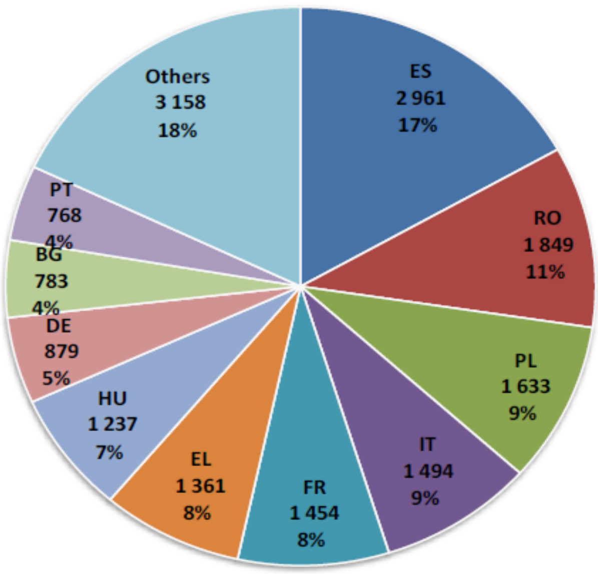

Fig. 1.2: The number of hives in the EU, thousands of families (Eurostat, 2018);

In Europe, we find that the number of beehives has declined sharply in the long run, while the amount of honey produced has remained fairly stable.

The number of beehives thus decreased by 25% during 1965 and 2016. This decline in the number of hives began, especially around 1985 and has largely stabilized since 1995. The reasons for this decline mentioned in both literature and and in official documents, as well as in interviews and surveys are as follows:

- the economic factors (low profitability due to import pressure and increased purchasing power of large intermediaries, such as wholesalers and retailers);
- biological factors (pests and diseases);
- chemical factors (insecticides and pesticides);
- environmental factors (anthropogenic degradation).

The analysis of these factors allows the measurement of:
• the decline of bee colonies;
• identification of causes and solutions;
• lack of access to the results of applied research;
• insufficient understanding of the economic opportunities offered by the diversification of production, the integration of several horizontal and vertical activities and the marketing of other products, other than honey.

In the European Union, according to EUROSTAT data, there are about 600,000 beekeepers who managed 16 million hives in 2016, according to data reported by the Member States. Of the total number of beekeepers registered in the EU, only 4% of them own more than 150 hives. This number of 150 hives is considered as the minimum threshold for professional farmers who can provide them with the income necessary for subsistence. However, the figure indicates only an average value of the number of hives, which provides the farmer with a viable income, because this boundary between professionals and amateurs may differ from one region to another, depending on the profitability of the production activity or the income levels that differ from region to region.

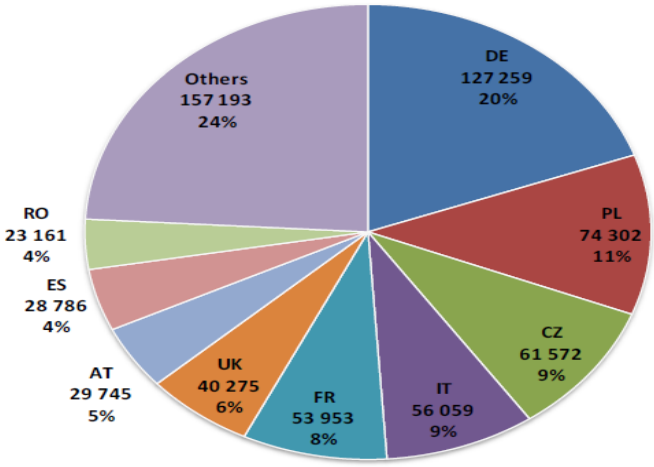

Fig. 1.3: Number of beekeepers in EU, 2019 (Eurostat).

Beekeepers, which can be found in all EU member states, have large differences in number and size. Thus, Germany owns one in six beekeepers, at the same time in Cyprus, Luxembourg and Malta, only a few hundred beekeepers can be found. In Italy, beekeepers who have more than 150 beehives also own 60% of all bee colonies. About 72% of the total number of beekeepers in the EU are organized in professional associations. According to EUROSTAT agricultural statistics, this declining trend in the number of beehives in France, Italy, Poland and Spain is confirmed. In these countries, there has been a sharp decline in the number of beekeepers and the number of hives in recent years.

In Romania, approximately 20,000 tons of bee honey are produced annually. In terms of the honey production, our country ranks third in the European Union, after Spain and Germany. The number of registered hives is about 1.47 million bee families. In Romania, 40,000 beekeepers are registered nationally and over 60% of them are members of the Association of Beekeepers. These beekeepers manage a number of 900,000 bee families. According to the Romanian Ministry of Agriculture and Rural Development, the highest honey production is registered in the counties of Brăila, Caraș Severin, Mureș, Sibiu and Vâlcea.

In Romania, beekeeping has long been one of the important branches of the agricultural sector. The ancestors of the Romanians kept bees for the production of honey and wax. In Romania, there have always been natural conditions favorable to beekeeping. This is due to the significant honey resources and specific climatic conditions that favored a yield of high-quality bee products. Romanian honey has been recognized for its healing properties and diversity in international competitions.

In support of the development of the beekeeping sector, we find a series of policies whose effect has been observed since 2000, when the number of bee families managed to register a phenomenon of progressive growth. This increase in the number of bee families has thus emerged amid financial support provided to beekeepers by the government by way of measures to stimulate rural development. Thus, in a first stage the government supported the development of this sector through its own policies, and then these rural development policies acquired a new dimension, due to European funds allocated to agricultural and rural development policies after Romania's integration into the European Union.

For the rural development and the beekeeping sector in Romania, an efficient strategy of resource allocation aims at intensifying and diversifying the production by increasing the number of bee families and at the same time by increasing the quality of honey production. Analyzing the effects generated by the financial aid granted to beekeepers in Romania through the National Beekeeping Program and also the potential of beekeeping determined by the pedoclimatic conditions and honey base in Romania, we find an economic recovery of the beekeeping sector due to the management of a larger number of beesduring 2010-2020.

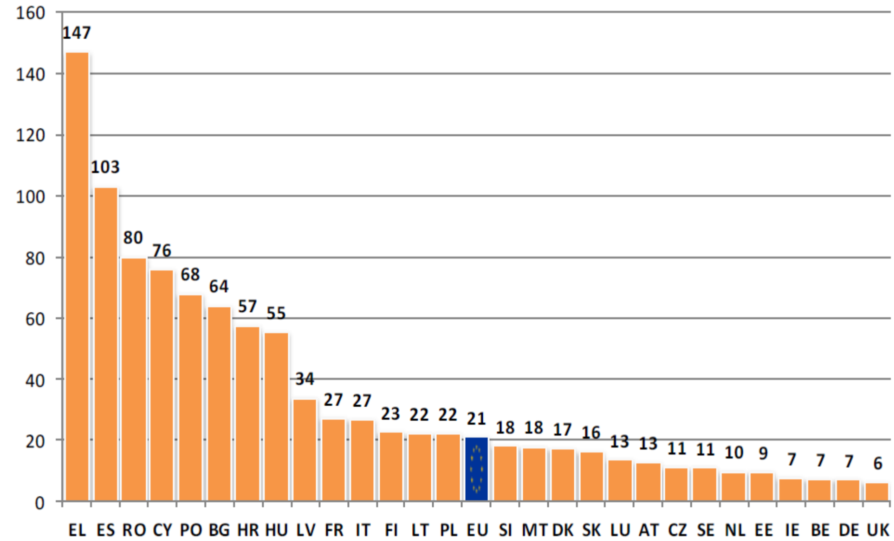

Fig. 1.4: Number of hives per beekeeper, 2018 (Eurostat).

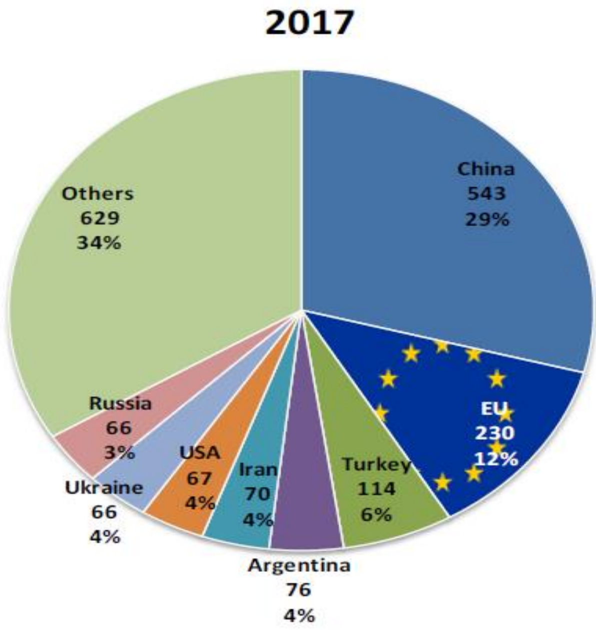

Fig. 1.5: World honey production, thousands of tons (Eurostat, 2018).

The European Union (EU) is the second largest producer of honey in the world and this position gives it an important role in the beekeeping market. According to data provided by EUROSTAT, the production of honey obtained in the EU was about 250,000 tons. However, this production fails to meet demand. In order to ensure the necessary honey in the EU in 2016, about 200,000 tons of honey were imported. Honey imports come mainly from China, which accounts for about 40% of EU imports.

Honey is the main product obtained in beekeeping, although other bee products (royal jelly, propolis, pollen and beeswax) and services (for example, renting bees for pollination) offer the opportunity of niche markets, which are an important source of income for beekeepers. Beekeepers in EU member countries produce 250,000 tons of honey a year which places, according to fig. 1.5, the EU secondly as a world producer with 12%, after China which has a share of 29% of world production. However, the EU fails to meet the demand from the domestic production and China is the main source of honey imports for the EU.

In Romania, polyfloral honey is the variety that holds the largest share in total honey production each year with a share of 50%, followed by acacia honey with 35% and lime honey with 15%. At the same time, the annual production of pollen increased to 50-60 tons, and that of propolis to 25-30 tons. The production of honey obtained in organic system amounts to about 3,200 tons, there are 130,000 families of bees certified in organic production system. Analyzing the structure of honey production, we find that most of the production comes from small producers, this being a defining feature of the domestic market. In terms of honey consumption, Romania is among the countries with the lowest rates in Europe. According to European statistics in the field, a Romanian eats around 450-500 grams of honey annually, a consumption that has a growing trend compared to that recorded 10 years ago. Compared to the five kilograms consumed in Denmark, two kilograms in Germany or 1.5 kilograms in the Netherlands and Belgium, Romania stands towards the end of the European ranking in terms of annual honey consumption.

With a low level of consumption, the large export of Romanian honey is justifiable (60% of domestic production). The main destinations for honey exports from Romania are: Germany, Great Britain, Italy, France, USA, Canada, Japan and China. According to fig. 1.6, Spain is the largest European producer of honey (33,000 tonnes per year), followed by Germany, Romania and Italy (approximately 22,000 tonnes each) and Portugal (21,000 tonnes).

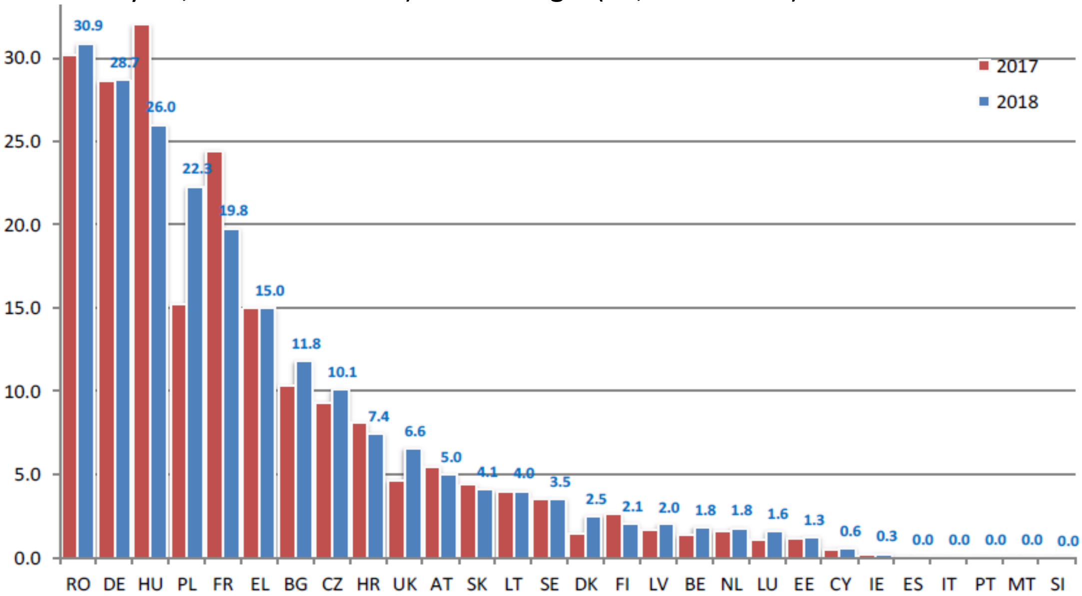

Fig. 1.6: The evolution of honey production in UE, thousand tons (Eurostat, 2018).

Bee honey, as the main product of beekeeping, is appreciated both for its nutritional properties and for its therapeutic effects. Bee honey is obtained from nectar, manna or sweet juices, which are found in different parts of plants and trees, mixed with some substances that form in the salivary glands of bees. In 2011, Romania ranked 17th in the world's top of bee honey producers with a production of approximately 21 thousand tons.

The economic importance of beekeeping as a branch of agriculture is given by the value of bee products directly obtained, which man harvests from bees, but also by the value of products obtained in other branches of agricultural production, which are obtained from cultivated and spontaneous plants by pollination. The activity of agricultural crops pollination and spontaneous flora is of particular importance for the survival of biodiversity as a whole. The biodiversity of spontaneous flora determines the medical value of bee products, which are successfully used in apitherapy in order to treat various diseases. The annual production of honey in the world is, on average, about 1.2 million tons. A fairly large share, about a third of the total production, namely 420 thousand tons, is sold on the international market.

Bee honey production in the EU has remained fairly stable over the last decade. If we find a relatively sharp growth at the beginning of the first decade of the century, however, it remained within the range of ± 2.5% of the multiannual average for the rest of the period.

Chapter 2 THE APICULTURAL POTENTIAL

2.1 Introductory notions - definitions, classifications, biological diversity, characteristics

A) Defining the basic terms

The apicultural potential of the Black Sea Basin Region is subject to ecopedoclimatic and anthropogenic factors. However, the geographical position of the region and the whole natural environment largely influence its structure and size.

The apicultural potential includes a series of plants from the spontaneous and cultivated / planted flora of Romania, Bulgaria, Turkey, Ukraine and the Republic of Moldova; plants that, by secreting nectar, pollen and even manna, provide bees with the raw material necessary for the nourishment and development of their families, fall into the category of honey plants.

For example: The Black Sea coast of Bulgaria holds 35.8% of the melliferous plants of the floristic region: the total honey dendroflora of Bulgaria - 307 species (Alexander N. Tashev, Evgenia S. Velinova & Evgeni I. Tsavkov, 2015); the South-East Development Region has a very high number of honey plants. Out of the 363 species reported for Romania, the same group of plants that ensure the main bee harvests are prominent at national level (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, p.3, 57)

Blossoming from February / March until the end of October, these plants from the Black Sea Basin Region provide pollen and nectar to bee families throughout the active beekeeping season. In addition to the honey sources mentioned – namely pollen and nectar - bees also collect manna (honey dew) during certain periods of the active beekeeping season that occurs frequently in resinous and broadleaf forests; also, the highly concentrated sugar secretion is considered to be a honey source (50-80%) coming from flower buds and fruiting shrubs before the flower opening with an impact on the development of bee families (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, p.9).

All the plants that are searched by bees for nectar, manna or pollen together make up the honey base (Law on beekeeping no. 383/2013 updated in 2020 - Romania).

Honey plants within the useful range of the collecting bees (up to 3 km, i.e. on a land of up to about 28 km2 / 2800 ha) of a farm or apiary, the distance to which these plants can be economically exploited, makes up the basis honey of the respective farm or apiary (Florian Vizireanu, 2020; Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, p.9; Modvala Susana, 2018, p.28).

As a science, the melliferous base is "a branch of beekeeping that deals with the study of honey resources provided to bees by both cultivated and spontaneous plants, as well as manna producers, as well as with the methods used to improve and increase these resources in order to raise the productivity of bee families and the increase of the proftability in the beekeeping activity” (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, p.9).

B) Biological diversity – essential characteristic of the honey base

Biological diversity influences the size and quality of the melliferous base. Only the conservation of biological diversity ensures the maintenance of a rich / solid melliferous base for the sustainable use of its components. This aspect supports beekeeping, one of the traditional occupations that brings ecological and socio-economic benefits. From an ecological point of view, bees are considered vital biological resources and as a result of pollination they play an essential role in the perpetuation and survival of many plant species on Earth; bees are a real barometer of ecological balance (Ștefan Lazăr, 2007, page 4,6.)

Many countries in the world are signatories to the "Convention on Biological Diversity", considering that protected areas are an important method of preserving biodiversity in the context of economic development; the purpose of natural areas is to achieve long-term nature conservation (IUCN, International Union for Conservation Union of Nature). Countries from the Black Sea Basin Region are also joining this trend.

The "Convention on Biological Diversity" supports the conservation of biological diversity as a common concern of humanity, already aware of the importance of biological diversity for the evolution and conservation of biosphere support systems. At the same time, it is reported that:

• states are responsible for the conservation of their biological diversity and the sustainable use of their biological resources and they are also concerned that biological diversity is significantly reduced by certain human activities;

• it is vital to anticipate, prevent and address first-hand, the causes of significant reduction or loss of biological diversity;

• a large number of local communities depend on the biological resources that traditional lifestyle is based on and that it is desirable to share equitably the benefits of using traditional knowledge, innovations and practices on the conservation of biological diversity and the sustainable use of its elements.

Global biodiversity is threatened by a number of factors such as the intensification of agriculture, the abandonment of extensive agricultural practices, climate change, pollution, the expansion of the living space, etc.

To counteract these threats, there are states in the Black Sea Basin that, transposing the EU's biodiversity strategy at the national level, are successfully implementing biodiversity conservation measures on agricultural and forestry land, maintaining traditional, extensive agricultural practices based on a low input usage, to encourage the pursuit of agricultural activities in areas facing natural or other specific constraints, to support organic farming and to preserve genetic diversity.

It is a priority need to increase the forested areas by contributing to the process of adaptation to climate change and reducing GHG emissions.

Significant areas of agricultural land, affected by various soil degradation phenomena, are suitable for afforestation. There is a strong link between the need to promote biodiversity and afforestation and the need for training and advice at local level to promote good practices in agriculture and forestry in terms of landscape and ecosystem management.

These concepts are relatively new in Romania and Bulgaria and there is potential for these ideas to be consolidated in the culture of farmers and foresters

For example, Romania, due to its geographical position, is one of the privileged countries on the European continent whose territory includes over 5 of the 11 biogeographical regions of Europe (alpine, continental, Pannonian, steppe and Pontic) and it is situated at the junction of the palearctic, Mediterranean, Pontic and Eurasian floristic sub-areas (National Strategy for Sustainable Development of Romania, timescales 2013-2020-2030", Bucharest, 2008, p. 19). This fact explains the high biological diversity, expressed both at the level of ecosystems (natural and semi-natural) representing about 47% of the country's surface and at the level of species. Studies conducted through the CORINE Biotops Program (National Biodiversity Conservation Strategy) have identified 783 types of habitats grouped in meadows, forests, agriculture, wetlands, swamps, hillock, etc. which reflect the diversity of flora and fauna species.

The South-East Development Region is highlighted by biological diversity, includes honey flora as an important part of Romania's honey heritage, insufficiently capitalized on its current dimension.

It is also mentioned that in many localities of the Republic of Moldova the nectar-pollen potential of spontaneous flora crops is not used and in some districts with intensive agriculture, there is a critical deficit of pollinating bees (Modvala Susana, 2018); this requires improving the reproduction of biological resources and improving the technology of pastoral beekeeping.

C) Classification of honey plants

In the literature, for a good systematization and knowledge of plants there are different ways of classifying honey plants according to criteria and / or depending on the purpose of approaching the works.

a) <u>The beekeeping classification</u> is made according to the nature of the food provided to the bees by the plants: nectariferous plants - provide only nectar, such as cotton; pollen plants, plants in which, bees collect only pollen, such as hazelnuts; nectar-pollen plants - also provides nectar and pollen, such as acacia, lime, sunflower; manna-producing plants - host plants of manna producers, such as: fir, spruce (Florian Vizireanu, 2020).
b) In the <u>botanical classification</u>, plants are grouped in species, then species in genera (the superior category of species), several genera can be grouped in families and several families in orders, which according to the common fundamental characteristics, are grouped into a class (Florian Vizireanu, 2020; Petre Iordache, Ileana Roșca, Mihai Cismaru, p.67); for example, *linden* belongs to the order of Malvares, the Tilliaceae family and the Tilia genus with the species named Tilia cordata M, Tilia tomentosa M, Tilia platyphyllos S.
c) According to the economic-beekeeping share, the classification is made based on the economic results obtained in apiaries and agricultural holdings, that is how large the honey and pollen productions are (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2017)
d) According to the biological and economic classification, most often encountered in scientific papers, there is the following classification: trees and shrubs (native and introduced); spontaneous herbaceous plants, such as those from forests, hayfields and meadows, those that come up spontaneously in agricultural crops, etc.; cultivated plants that include: technical plants, fodder plants, leguminous plants, aromatic medicinal plants and specific honey plants, fruit trees (Vasile Alexandru et al., 1986, p. 281, 298; Florian Vizireanu, 2020; Pîrvu C, 2000, p. 909)
e) Biological classifications refer to the longevity of plants and their pollination modes (Florian Vizireanu, 2020; Petre Iordache, Ileana Roșca, Mihai Cismaru, 2017, p. 68, 69).
   e.1) According to the pollination-fertilization mode:
   • honey plants with direct pollination (apricot, raspberry, etc.)

• honey plants with indirect pollination: anemophilous (wind pollination) plants such as alder, poplar, spruce, fir, etc.); entomophiles (pollination by insects), such as cherry, apple; hydrophilic (water pollination) plants; malecophilous (pollination by molluscs); ornithophilous (pollination with the help of small birds (eg. hummingbirds).

e.2) According to longevity:

- annual plants: plants in the spontaneous flora (stubble basil, etc.) and cultivated plants (sunflower, rapeseed, etc.);
- biennial plants - have lower honey potential than annual ones and include plants from spontaneous flora (burdock, etc.) and cultivated plants (onion, etc.);
- perennials: forest trees (acacia, lime-tree, willow, etc.), forest shrubs (rosehip, raspberry, etc.), ornamental trees and shrubs (red acacia, Japanese acacia, etc.), fruit trees and shrubs (apricot, apple, currant, etc.)

f) According to the native and non-native specifics, the honey plants are grouped into: native wild flowers; native trees and shrubs; introduced trees and shrubs; introduced herbs and ornamental plants; native and non-native pasture honey plants (Eric Lee-Mäder, Jarrod Fowler, Jillian Vento, Jennifer Hopwood, 2018).

D) Characteristics of the plants that attract pollinators

Flowers react differently to certain pollinators, coexisting with them, providing them, on the one hand, with different flowering periods, colors, scents, shapes and rewards (pollen or nectar) and, on the other hand, improving their reproductive efficiency.

Depending on the characteristics of the flower, the number of visits made by pollinators increases or decreases.

Examples for the “communication” ways the plants have with honey bees and other pollinators (Eric Lee-Mäder, Jarrod Fowler, Jillian Vento, Jennifer Hopwood, 2018; Romanian Beekeepers Association, 1986, p.220)

a) *Favourable disposition in receiving visits by the shape of the flower;* significant are the compounds (sunflower), crucifers (rapeseed, mustard), rosacea (fruit trees, raspberries), lime, edible chestnut, etc.
b) *"ultraviolet invitations";* flowers in the ultraviolet range attract more pollinators than those in shades of light red less;
c) *color;* in various stages of development, many flowers transmit signals to pollinators by changing color;
d) *“nectar guides”;* the shades / tones of the flowers direct the pollinators towards the floral reward, the nectar / pollen respectively;
e) *floral odor* (minthy, sweet, pungent, etc.), the result of chemical compounds, varies in intensity and concentration depending on the species, flower age and soil conditions and can attract certain pollinators from long distances.

Fig. 2.1 photo (July 22, 2020) - capturing the moment of pollination within the apiary (located in the Danube Meadow, Tichilești, Brăila County, Romania) of a beekeeper in the Black Sea Basin network.

2.2 IMPORTANT HONEY PLANTS IN TERMS OF BEEKEPING AND GEOGRAPHICAL DISTRIBUTION

Many plants bloom at a distinct seasonal rate that can be synchronized with the life cycle of certain pollinators. Melitophilous flowers are visited by bees, bumblebees and wasps. However, depending on the time of day, environmental factors and the individual life cycle of a plant, depending on the species, variety, etc. these pollinators visit the flowers to obtain the desired rewards - pollen, nectar, oils and / or resins. Bees have an important role in plant pollination and in beekeeping activity.

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An important condition for the profitable growth and maintenance of bee families in order to obtain bee products (honey, pollen, wax, etc.) is the knowledge of honey plants, their geographical distribution, blossoming period and their nectar-pollen value.

2.2.1 TREES AND SHRUBS

A) The linden tree

The linden tree - is part of the Malvales order, family of Tiliaceae and genus Tilia, the only representative of the family in Europe and has at least 25 species, of which 3 are well known in the Black Sea Basin - the large-leaved lime (*Tilia platyphyllos*), the small-leaved lime (*Tilia cordata*) and the silver lime (*Tilia tomentosa*).

Linden tree features		
The large-leaved lime *(Tilia platyphyllos)* **- (c.)**	**The small-leaved lime** *(Tilia cordata)* – **(b)**	**The silver lime** (*Tilia tomentosa)* **–(a)**
Tree that can reach 30-40 m in height, with a straight trunk up to about 1 m in diameter, wide and globular crown.	Tree with heights of up to about 20 m, with a straight and elegant solid stem and about 1 m in diameter.	The tree can reach 30 m in height, dense crown and branches pointing upwards; the silver color of the crown makes it stand out from a great distance.
Green-olive to reddish-brown stems, either glabrous or rare-bristle leaves.	The annual stems are green - olive to reddish, with distichous, ovoid, glabrous buds and two outer scales.	The stems are brown-yellow and tomentuos.
The leaves are 6-15 cm long, about 8 cm wide, subround to wide ovate, sharply serrated on the edges, showing tufts of whitish or yellowish hairs on the back and (sometimes) prominent parallel tertiary veins;	The leaves are about 9 cm, wide – oval in shape, with a suddenly acuminate tip, cordiform or obliquely truncated at the base, often asymmetrical; dark green on the face, gray-green on the back, with tufts of reddish axial hairs. Despite the name of the species (small-leaved linden), its leaves are similar to those of the large-leaved linden.	The leaves are about 10 cm long, 6-8 cm width, dark green on the face, starry-grey on the back or tomentous-white ; no axial hair.
It blooms annually in June and July, before the small-leaved and the silver lime. It blooms annually in June and July, before lime and silver lime. The white or pale-yellow flowers are fragrant and are grouped into 4-5 clusters (missing the staminodes); they are pollinated by insects.	It blooms annually in June-July, after the large-leaved lime tree. The white or pale-yellow flowers are fragrant and are grouped into 4-5 clusters. They are pollinated by insects.	It blooms annually, after the large-leaved and the small-leaved linden tree. The flowers are in pendant inflorescences, each (3) 5-10 stellate tomentous, the stalk being shorter than the leaf; they are pleasantly - fragrant and pollinated by insects.
It has increased demands of heat (subthermophilic) and it is relatively resistant to drought.	It prefers more temperate climates in the growing season than the other 2 species of linden, in regions with more rainfalls, which explains its presence at higher	It adapts well to hilly regions and rarely to mountains on the lower floor in hot climates and withstands better than the small-leaved lime the dryness of the atmosphere

	altitudes, on hills and on the northern slopes of low hills, where atmospheric humidity is slightly higher.	and soil; shows sensitivity to frost.
It adapts well to reddish-brown, deep and well-structured soils. It can hardly withstand high compactness and excess moisture.	It grows well on fertile, humic soils, rich in nutrients, deep and aerated, weakly acid-neutral, with a constant humidity regime. It does not adapt to compact, poor and excessively damp soils, nor to saline soils.	It grows vigorously on fertile, eubasic and eutrophic soils, weakly neutral and loose acids. It is tolerant to compact soils, but not excessively compact, advanced pseudogleized and dry; it does not adapt to excessively moist, hydromorphic soils in river meadows.
- Petre Iordache, Ileana Roșca, Mihai Cismaru, *Honey plants of very high and high economic and apicultural share*, Bucharest, 2008, pp.113- 117; - Romanian Beekeepers Association, The Beekeeper's Manual, 6th edition, Bucharest, 1986, p. 282-283; - Florian Vizireanu, Training in beekeeping, course support (for the beekeepers' course in the Black Sea Basin network, South-East Development Region), Romania, 2020		

Lime blossom and flower nectar secretion is a complex biological process that depends on several factors: ecopedoclimatic conditions, relief (by altitude, orientation of the slopes towards the sun, etc.), tree age, photosynthesis process, etc.

The studies have highlighted several aspects regarding the honey characteristics (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, pp 123-126; Romanian Beekeepers Association, 1986, p.283; Florian Vizireanu, 2020)

- the process of lime nectar generation depends on the presence of reserve substances stored in trees, as well as on the existence of stimulants that are building up even during the flowering period;
- the nectar secretion depends on the variety of lime, soil fertility and climate;
- the extent of blossoming and nectar secretion varies depending on the light; the number of flowers and the nectar amount secreted are reduced under shading conditions of the linden crown;
- brightly lit linden trees bloom abundantly, their flowers yield two times more nectar than the flowers of the shaded ones, a state noticed in the case of different parts of the tree crown. The largest amount of nectar is obtained from the flowers at the top of the crown;
- the largest amount of nectar is found in the flowers placed in the part of the crown exposed to the north in dry periods; more nectar is to be found in the flowers of the crown exposed to the south but after the rains;
- the largest amount of sugar is in the nectar of the flowers in the lighted part of the crown (2 times more) than in the shaded part of the crown, because the products of photosynthesis are transported to the inflorescences in that part;

- the nectar secretion is at its best in hot weather, with rare hot rains and, especially, after rains before blossoming;
- nectar secretion is at the most at the beginning of blossoming, around 3.84 mg, and it decreases towards the end of the flowering period, and the sugar content in nectar varies depending on the weather, between 13.3 -42.2%;
- the nectar secretion of linden flowers begins at temperatures of at least 16 ° C, increases visibly after 20 ° C and at over 33 ° C to cease completely when the flower withers and may fall;
- small amounts of nectar are recorded in years with unfavorable weather conditions during the flower buds formation and during the lime blossoming:
- lime blossom, nectar secretion and its sugar content are influenced by the amounts of rainfall during July-September of the previous year, of at least 140 mm (1mm = 1 l / m2), so that the root system extracts from soil a sufficiently large amount of mineral substances to contribute to the formation of inflorescences, obviously in the following year, to the accumulation of sugar reserves for a normal or even abundant secretion of nectar;
- lime trees, in some years, do not yield nectar or only a very little amount, although the precipitation is significant, either because the flower buds have been attacked by frost after the vegetation began, or because in July-September period of the previous year, the soil moisture was very low;
- linden trees bloom every year and have a higher density of flowers when they grow isolated or in small groups than those in massif / dense plantations;
- by the succession of the 3 species of linden blossoming in massif groups, a long flowering period is ensured; in the case of the Romanian area, the period takes usually about a month, and begins with the large-leaved linden (about 20 days after the end of the acacia blossoming), followed at 10-15 days by the small-leaved lime and at 21-22 days by the silver lime;
- the blossoming of the same species at different moments can be obtained where the linden massifs are located on two different slopes in terms of exposure to the sun;
- a large production of honey by the bee families in the beekeeping practice in linden massifs is obtained if lindens produce abundant flowers, if the nectar secretion is as high as possible and the blossoming period is as long as possible; the bee families should be in an active state (not to be swarming) and with a sufficiently large population and the apiary to be as close as possible to the linden massif (maximum 1.5-2 km);
- in a lime honey harvest, 2-6 kg of honey can be made per day in favorable conditions per a normally developed bee family;
- there are cases when in the first days of blossoming, due to volatile ethers emitted, especially the theobromine, the hives of bee families are depopulated.

a) **The silver linden** (or *Tilia tomentosa,* the scientific denomination) is more of a Balkan-Pontic species, with the most restricted native range compared to the other 2 species of linden (the large and the small-leaved), extending from South, at the level of the 40 degrees parallel north latitude on the territory of Greece and from the Northern extremity of the Aegean Sea (near

Greece) to slightly higher latitudes (48 degrees North latitude) under the form of more stripes over the territory of Romania and the Republic of Moldova to Slovakia and Ukraine.

Obviously, the Black Sea Basin region comprises the Eastern part of the native area which overlaps Bulgaria (that fully benefits from this), Turkey (in the western extremity of the European part), Romania (in the North of Dobrogea and the higher hilly and plateau areas of Vrancea, Buzău and Galați counties), the Republic of Moldova (the entire surface of the country, except for the Southern extremity); isolated populations are registered only in Turkey.

It prefers warmer climates in the growing season, especially in the lower regions (plains, hills) and tolerates drought in the atmosphere and soil better than the small-leaved species. The blossoming occurs in June-July. For example, in normal weather conditions in Romania, it blooms about 20 days after the large-leaved linden and lasts for between 1-2 weeks.

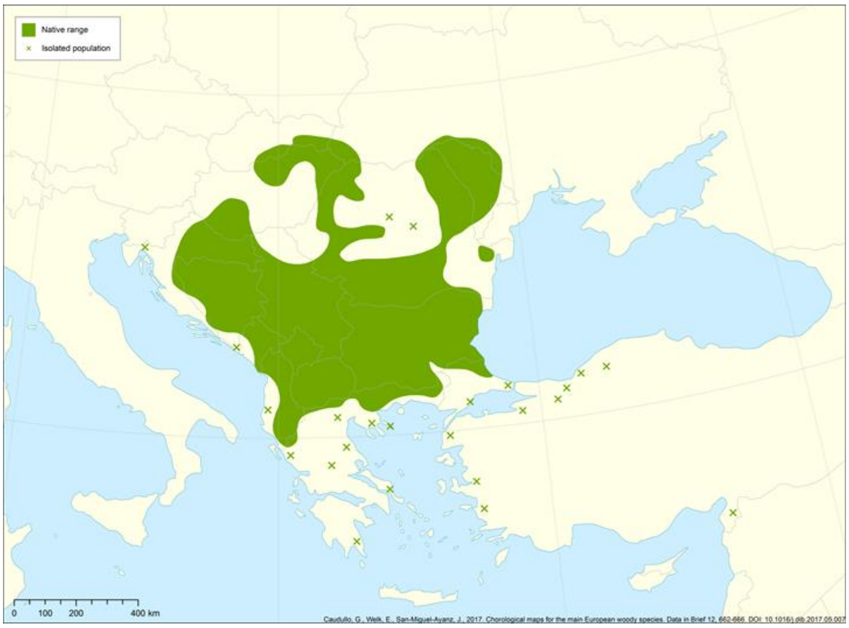

Fig 2.2. Silver lime *(or Tilia tomentosa)*
Source: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007

<u>b)</u> **<u>The small-leaved lime</u>** <u>or *Tilia cordata*</u> (scientific name) is a native in Europe.

At the level of Europe, the native range extends from the 40th parallel (near the Balkan Peninsula) to beyond the 60th parallel North (Southern Finland, Sweden, Norway, etc.), and in longitude from the West of the continent (West of France, the Southern part of Great Britain) to the territory of Russia, beyond the Ural Mountains (see Fig 2.3 - Pilia linden (Tilia cordata) or the small-leaved Lime.

Thus, the Eastern extremity of the native area of Tilia cordata overlaps the Black Sea area: Ukraine (native area and isolated population), Republic of Modova, Romania and Bulgaria (native area); the Eastern limit of the area of this species does not reach the territory of Turkey, only isolated populations are present in the Bosphorus Strait area.

In general, linden is found in the Black Sea Basin mixed with other species, being disseminated in the case of forests in different proportions from 10% to 50-75% (only on the territory of Romania, it reaches this extent).

It prefers more thermally moderate climates in the growing season (with warmer summers), it is located in regions with more rainfalls (up to around 800 mm / year), even if it is more tolerant of drought, on soils with a relatively constant regime of humidity, which explains the presence at higher altitudes (sometimes going up the slopes to the areas of coniferous vegetation as in the case of the Romanian space) and, at the same time, on the Northern slopes of the lower hills. It is not much affected by spring or autumn frosts because blossoming is late in the year.

Considering that the duration of blossoming depends on the weather conditions and the local factors (geographical position and relief in particular), it varies from one area to another. For example, in the Romanian space of the Black Sea Basin Region, it blooms in the first part of June and lasts between 8-12 days (Florian Vizireanu, 2020).

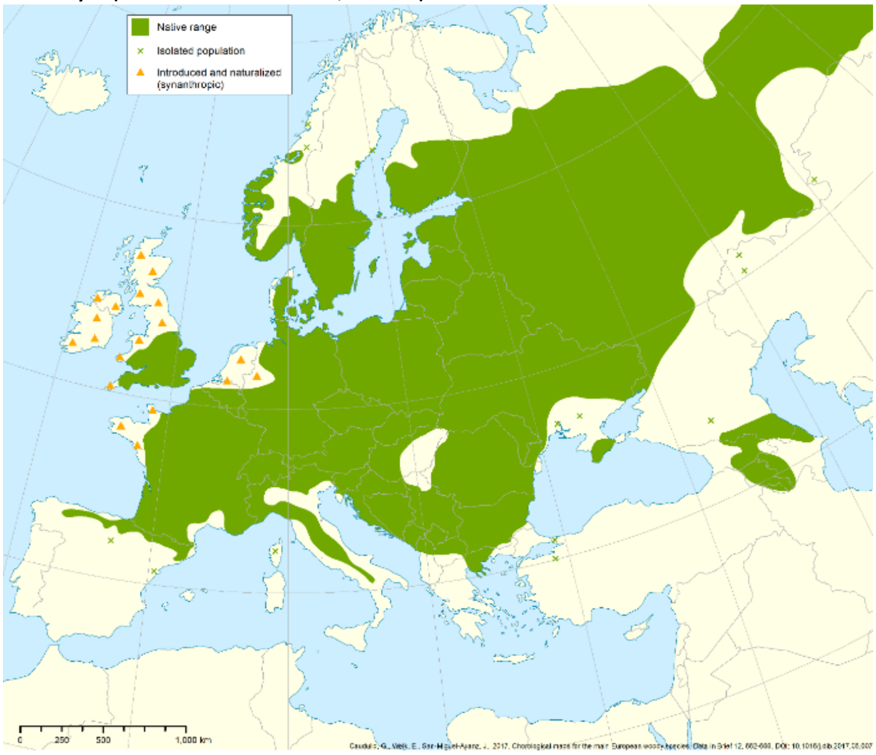

Fig 2.3 The small-leaved linden tree *(Tilia cordata)*

Source: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007

c) **The large-leaved lime** or Tilia Platyphyllos (the scientific name), native to Europe, in the case of the European continent, has a smaller native range smaller than the small-leaved lime: in the South, it reaches the 40th parallel near the Balkan, Italic and Iberian peninsulas, and in the North the 55th parallel to Poland, Germany. It benefits from the Eastern part of the native area with compact disposition recorded in the Black Sea Basin Region of the Republic of Moldova (West of the central and Northern part), Romania (South-East Development Region, through Galati County, Northern Dobrogea and the higher relief part of Vrancea and Buzau counties), Bulgaria (near the Gulf of Varna) and Turkey (only on the European coast); otherwise, in the form of isolated populations, it is found along the Turkish Black Sea coast.

Like Tilia cordata, it is a tree that prefers more the lower areas climates and the warmer hills during the vegetation period. It blooms for 8-15 days (Florian Vizireanu, 2020).

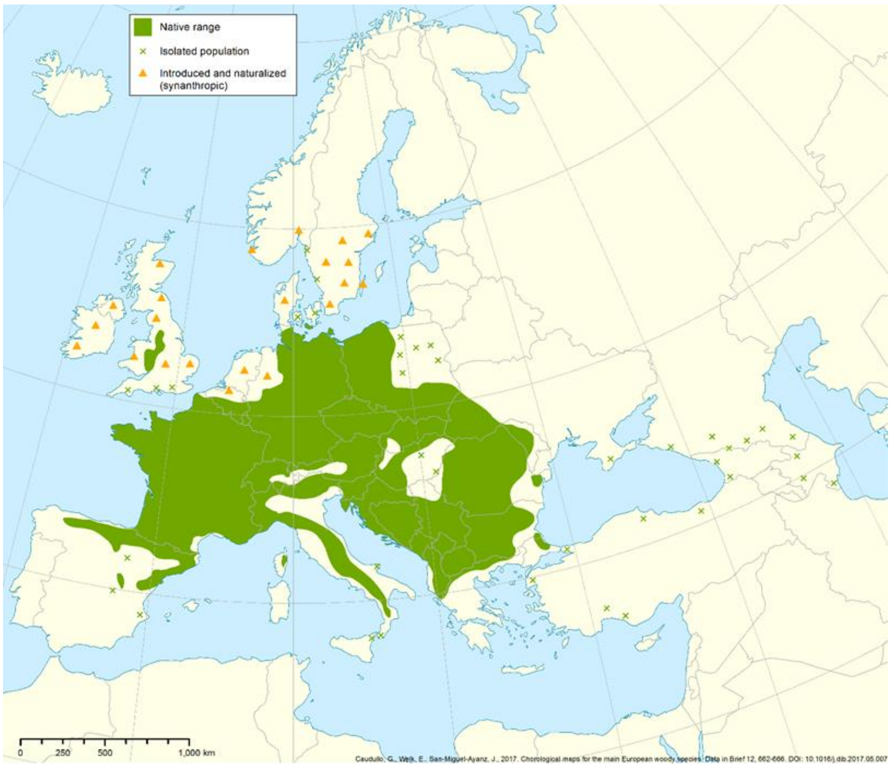

Fig 2.4. The large-leaved lime *(Tilia Platyphyllos)*
Source: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007

In general, the 3 species of linden trees in the Black Sea Basin Region are found mixed with other deciduous species, such as oak, hornbeam, sessile oak, etc., in all associations participating in different proportions, reaching 90% or forming pure stands (as, for example, on the territory of Romania in the north of Dobrogea, "Niculițel Forest", natural area of national interest since 2000, with an 11 hectar-wide area).

By overlapping the three maps, it tuns out that in the Black Sea Region, the countries that fully benefit from the existence of the 3 species are: Bulgaria, Romania and the Republic of Moldova. Therefore, these countries are considered to have very high and high economic share honey plants.

Lime honey is highly sought after on the domestic market of each of the mentioned countries, as well as on the European market. The evaluated honey production is: for the large-leaved lime, 800 kg / ha, for the small-leaved lime, 1,000 kg / ha, for the silver lime of 1200 kg / ha in normal climatic conditions (Romanian Beekeepers Association, 1986, p .283; Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, p.124). As compared to the 1990s, the area occupied by lime trees is increasing.

B) Acacia

The white acacia (*Robinia pseudoacacia* - the scientific denomination - commonly known as the Black locust) is a species of North American deciduous tree, introduced to Europe in the early seventeenth century, first in France; Jean Robin, the gardener of King Henry IV of France, planted the first white acacia in Place Dauphine, Paris (Valeriu-Norocel Nicolescu, Cornelia Hernea, Beatrix Bakti, Zsolt Keserű, Borbála Antal, Károly Rédei, 2018).

This non-native species of the European forests was later extended to plantations in Central Europe in the late 18th and early 19th centuries, then massively for afforestation in south-eastern Europe. Currently, Robinia pseudoacacia is widespread throughout Europe, almost naturalized throughout the continent from Sicily to Southern Norway and from the Portuguese coastal regions to the Caucasus (Valeriu-Norocel Nicolescu, Cornelia Hernea, Beatrix Bakti, Zsolt Keserű, Borbála Antal, Károly Rédei, 2018). White acacia covers large areas in Romania, Bulgaria and Ukraine.

It is also found on other continents, including Asia. It is a heliophilous species with little shade tolerance, grows well in regions with long and hot summers on a wide variety of soils, it does not prefer regions with early frost, but has a rapid growth and vigorous regeneration sometimes invading lands conducive to growth and development (Alexandru Liviu Ciuvăţ, Ioan Vasile Abrudan, Viorel Blujdea, Cristiana Marcu, Cristiana Dinu, Mihai Enescu, Ilie Silvestru Nuţă, 2013).

It is a species with a special value, with multiple uses, that is why it is cultivated as a forest essence (with heights up to about 30 m, straight stems, over 80 cm. in diameter), as an ornamental and honey plant; it is a nectariferous, honey, and manna-producing species, with a high economic-apicultural weight.

Due to the wider limits of ecological sustainability known from experiments conducted in over 170 years of cultivation (fixing the slopes, protective curtains on the fields and along roads, in landscaping) and the multiple usage, this species is frequently found in the space The Black Sea Basin mainly in the form of scattered trees and in the form of massif groups, forests and plantations.

The leaves of the trees are compound imparipinnate, with lengths of 10-30 cm, consisting of leaflets usually paired and opposite, with rounded tips and full edges, dark green on the face; hermaphroditic fragrant flowers have corolla from white to cream with a yellow spot inside, they are disposed in racemes 10-25 cm long (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007. P 91).

Blossoming occurs in May-June, annually and abundantly, depending on the climatic conditions imposed by general and local factors that obviously influence the time and duration of blossoming (it can last up to about 10 days in solitary acacias and a few days longer in those in massive groups). The amount of nectar and the sugar concentration depend on the exposure of the acacia mass to the sun, the flowering stage, the variety, the age and the density of the trees; nectar secretion starts at a temperature of +10 ° C and ends at 35 ° C (Florian Vizireanu, 2020). Also, depending on the conditions stated, the honey production obtained per hectar varies, usually between 800-1200 kg / ha, and for an usual acacia harvest, the extracted honey production can reach up to 25 kg per normally developed bee family (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007. P 96).

In the context of climate change, the importance of adapting this species to poor soils with high temperatures (eg. sand dunes) is expected to increase.

In addition to white acacia, there are a number of other acacia species, cultivated mainly in parks, botanical gardens or on the roadsides (obviously in Bulgaria), such as: **the yellow acacia, the pink acacia**, etc.

C) The maple tree

1) The field maple (in Latin, *Acer campestre L.*) is a medium-sized tree, generally reaching 15 m, rarely exceeding this height, and in diameter, the trunk reaches about 70 cm, the crown is like a vault; it rarely appeares as a shrub. The leaves are palmately lobed (with 5 rounded lobes), up to 16 cm long and up to 10 cm wide and it ranges from bright green to dark green, and in autumn to golden yellow, sometimes to red.

It is a dioecious species, as it produces unisexual, small, greenish-yellow flowers attracting bees, beginning to bloom in late April at the same time as the buds open or a few days before this.

The native range is compact in Europe, extending into Asia Minor, mostly between the parallels 40 and 55 ° North latitude, thus encompassing the entire Black Sea Basin Region (Fig. 2.5): Turkey, Bulgaria (all regions), The Republic of Moldova, Romania (partly - Northern Dobrogea and the high area of the Carpathian Curvature), Ukraine (partly).

According to the geographical distribution, it is found from the sea shore to the mountainous areas, it is part of deciduous forests (mixed with oak, etc.); it is also an ornamental tree.

It prefers a warmer climate, it tolerates the extreme temperatures of the continental climate and, at the same time, is is resistant in winter and spring frosts.

It is important for beekeeping, pollination is generally entomophilous, it provides nectar, pollen and manna to bees.

Under favorable conditions, the harvest of Acer campestre or jugastra (from a botanical point of view) is intense and long-lasting, exceeding 20 days, the nests of the bee families get frequently stuck with honey and the queens no longer have room for laying eggs (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, p 161); the estimated honey production reaches about 1,000 kg / ha.

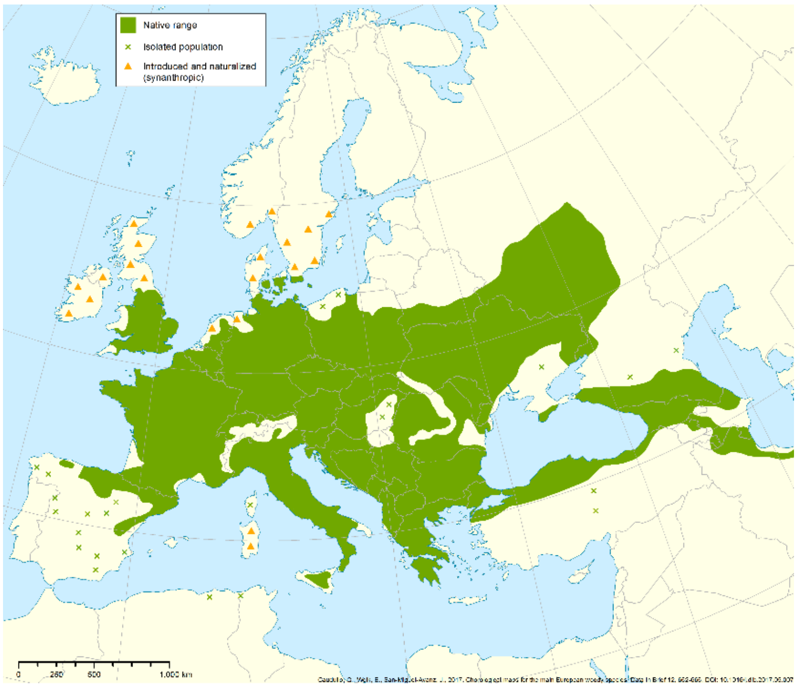

Fig. 2.5 **The field maple** (*Acer campestre)*

Source: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007

2) The Tartar maple (*Acer tataricum* in Latin) is found in the form of a tree or shrub, with heights of up to about 10 m, with a trunk diameter of about 30 cm, with a smooth dark gray bark. The leaves are broad-oval or oval-rounded, in autumn they turn reddish.

It blooms in May, before the acacia, and the flowers appear after the foliage being yellowish green, attractive to bees, favoring the harvest, that in optimal conditions exceeds 10-14 days. The Tartar maple is widespread in Eastern Europe, Western Asia, etc. It grows in forests (mixed with acacia, common maple, hawthorn, etc.), sometimes in a proportion of 30-40%, in low plains or hills, not in the high ones. It is cultivated in forest protection curtains in low areas, but also as an ornamental tree. It is important for beekeeping, provides nectar, pollen and manna to bees. The honey production is estimated at 300-600 kg / ha (The Association of Beekeepers from R.S Romania, 1986, p.284).

D) The pine

1) The Scottish Pine (*Pinus sylvestris L.* in Latin) is the most widespread species of pine, being drought tolerant and with a good frost resistance. It is often of medium height, 23-27 m, but can reach over 40 m. The leaves are aciform, arranged in pairs, 5-7 cm long, blue / gray-green.

It is a wind-pollinated species, the trees are normally monoecious, but the mature ones occasionally have only yellow or pink male flowers or only female purple-pink attractive to bees.

It is also found mixed with conifers, such as other pine species (Pinus nigra, Pinus uncinata), fir, spruce or deciduous trees as birch, beech, etc.

The species has a compact native area near the parallel of 45 ° North latitude on the territory of Italy extending to Northern and Eastern rest of Europe, to northern Scandinavia (see Fig. 2.6). Within the Black Sea Basin region, the native range overlaps the high areas - the Pontic

Mountains (Turkey), the Curvature of the Oriental Carpathians (Romania), the Crimean Peninsula; isolated native populations are spread in the Republic of Moldova (Southern part); isolated introduced populations occur in the Eastern Balkans (Bulgaria) and in Dobrogea (Romania). For beekeeping it is important for its resin, buds, aromatic oil, pollen and manna.

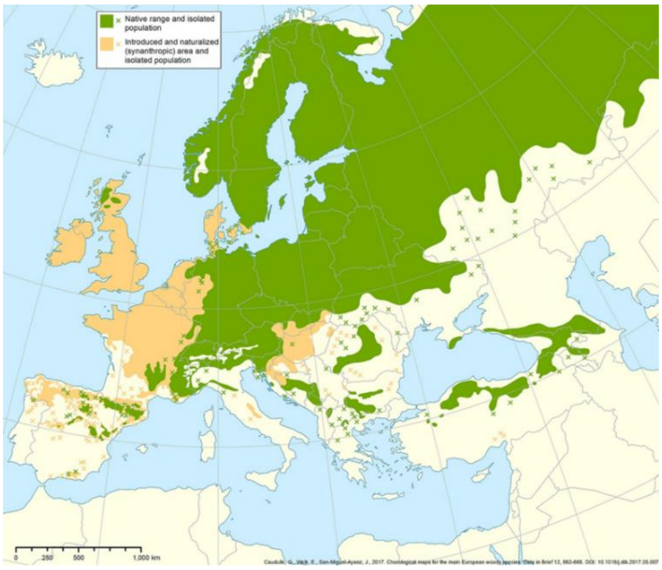

Fig 2.6 The Scottish pine (*Pinus Silvestra)*
Source: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007

2) Black pine is a coniferous specific to mountain areas and has a fragmented and limited area in Europe and Asia Minor, consisting of several subspecies.

The area is narrower than in the case of Pinus Silvestra, starts in the Mediterranean area and it reaches places beyond the parallel of 50 ° North latitude (near Denmark). Being more of a component of the fast-growing Mediterranean forest regions, it covers large areas in the Balkans and Asia Minor, being here one of the most widespread species appearing in certain places in a frequency even over 75% (The European Atlas of Forest Tree Species, 2018, p 126).

It is usually 30 metres tall, rarely higher; the crown is conical and it flares like an umbrella on older trees. The shell is dark brown-grayish to black (hence its Latin name "nigra"). The leaves are aciform, in pairs with lengths of 8-19 cm, to light green. It is a monoecious species, the male flowers are yellow, the female inflorescences are reddish.

In the Black Sea Basin region, it grows as a native area only in the Western and central part of the Pontic Mountains (with a frequency between 50 and over 75%) and in the Crimean Peninsula, apart from that, in some regions in Bulgaria (in populations with a frequency between 50 and over 75%) and in the Curvature area of the South-East Development Region of Romania (in populations in an extremely low frequency) (European Atlas of Forest Tree Species, 2018, p 126).

Pinus Nigra Pallasiana is a species of black pine that covers large areas in the Pontic Mountains and the Istrancea Massif (Fig 2.7).

In the field of beekeeping, the black pine is important for its resin, buds, aromatic oil, pollen and manna.

Project funded by EUROPEAN UNION

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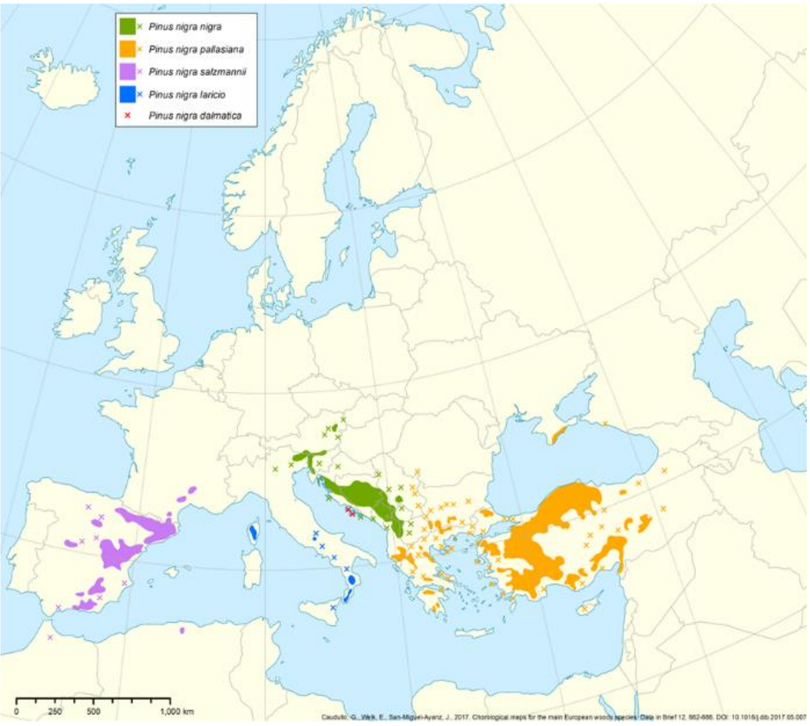

Fig 2.7 Pinus nigra pallasiana in the Black Sea Basin Region

Source: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007

3) The Turkish pine or *Pinus brutia* (Latin name) with apiculture properties, similar to the other pine species mentioned, is to be found in Turkey. It has been widely planted in regions along the Black Sea and the Mediterranean (see fig 2.8).

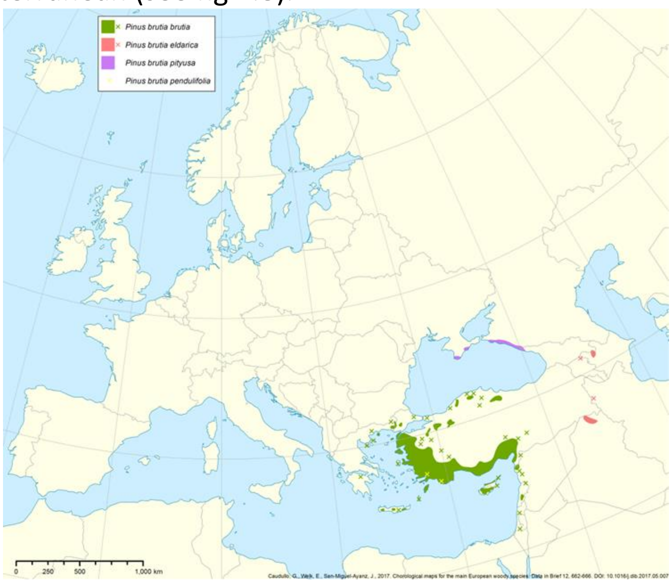

Fig 2.8 The Turkish Pine (*Pinus brutia*)

Sursa: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007

E) The fir tree

Several fir species are conspicuous in Europe and Asia Minor.

The silver fir (*Abies alba*) forms pure forests or it is mixed with other coniferous or deciduous species and has the largest areas generally superimposed on mountainous areas in Europe (Carpathians, Alps, Dinaric, Stara Planina, Rhodopes, Apennines, Pyrenees) compared to the other fir species (Fig 2.9). In the Black Sea Basin Region, the silver fir appears in the Carpathians Curvature (in Romania at altitudes of about 600-1200 m) and in the western extremity of the Bugarian territory.

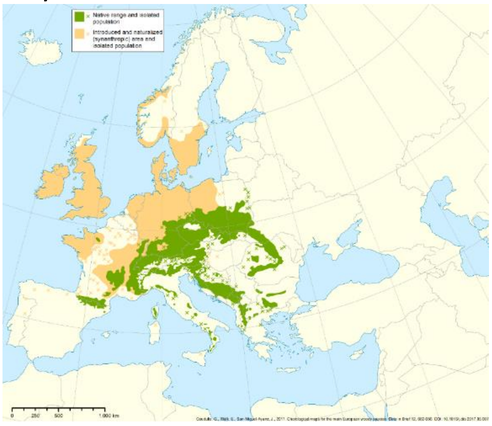

Fig 2.9 The silver fir *(Abies Alba*)

Source: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007

It frequently reaches heights of 35-40 m, sometimes even 50-60 m, the trunk is straight, cylindrical, the crown is conical in its prime. The needles are about 2-2.5 cm long, on a light green face, on the back, there are 2 wide white lines, being arranged pectineally. The flowers are unisexual, the females are arranged in erect, cylindrical cones, about 12-20 cm long, reddish-brown and the male flowers are grouped in thick and yellowish tips. It blooms in May-June, and pollination is anemophilous.

However, according to the map in the "European Atlas of Forest Tree Species" (2016, p. 50) in northern Turkey, where rainfall is over 1500 mm / year, other fir species appear, namely *Abies nordmanniana subs. equi-trojani* in the Western Pontic mountains in a wider area and Abies nordmanniana subs. nordmanniana (native to the Western Caucasus) in the Eastern Pontic mountains as small populations.

The stem is straight, it reaches up to over 60 m, the crown has regularly arranged horizontal branches in conical form, with the old trees, the crown gets flat or round (as in Abies alba). The needles are ordered twistedly towards the top, while the pollen cones, grouped along the lower parts of the branches of the current years, are reddish purplish. The fir tree is a honey tree, providing bees with significant amounts of resources - pollen, manna and propolis.

F) The chestnut tree

The edible chestnut or Castaneea sativa Mill (Latin name) is a deciduous tree species which has a spatial distribution in Southern Europe (Iberian, Italian, Balkan peninsulas) and Western Asia to the North of Great Britain (Fig. 2.10), and it terms of altitude, it grown up to 1,800 m, depending on the latitude and the local conditions.

It can be cultivated both in monoculture or can be easily combined with other fruit species, forming mixed orchards.

In the Black Sea Basin region, there is a native range in Turkey, along the Black Sea and the Marmara Sea, and it also appears in small populations, being introduced or naturalized in the South of the Republic of Moldova and in the Crimean Peninsula.

It has a straight stem, often reaching 20-25 m in height, and very old ages, over 100 years or even much more.

The leaves are long (8–28 cm long and 5–9 cm wide) with prominent ribs, bright green on the top, thorny-jagged on the edges.

It is a monoecious tree, with flowers arranged on 2 levels, the female flowers at the base of the male flowers (grouped in catkins up to 15 cm long), which develops at the end of June and in July, being pollinated by wind or by bees due to the strong smell (Florian Vizireanu, 2020); the female flowers grow until autumn in thorny domes containing 3-7 brown nuts.

In addition to its valued fruit in the culinary arts and confectionery, it provides a rich harvest for bee families during June and July; honey production (yellow-golden color) is estimated at 50-120 kg / ha (Petre Iordache, Ileana Roșca, Mihai Cismaru. 2007, p.73).

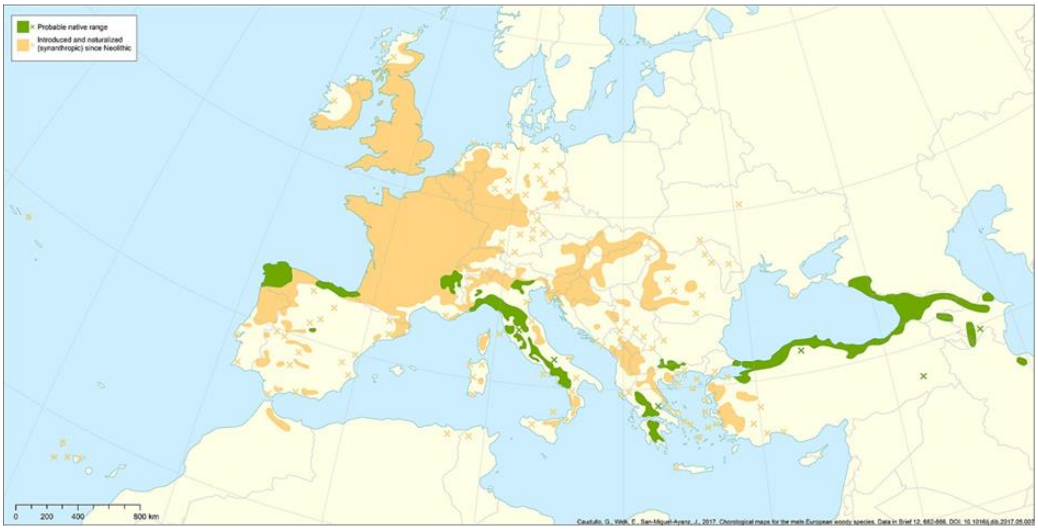

Fig.2.10 The sweet chestnut (*Castaneea sativa)*

Source: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007

G) The willow tree

1) The white willow is one of the best known and the largest of the willows, part of the Salicales order, genus Salix and its name (Salix Alba L. in Latin) comes from its pale silver leaves.

It can reach heights of up to 30 m, the trunk diameter grows up to about 1 m or more, the leaves are alternate, lanceolate, up to about 10 cm long, with small serrated edges, silver-gray on the top (on the face) and silky and dense white hairs on the underside. The flowers are unisexual-dioecious, the male flowers are yellowish up to 5/6 cm long, the females are yellow – green, becoming fluffy white and attracting bees.

It grows rapidly in temperate climates, on high humidity soils at the sea level to the mountains - on waterfronts, in meadows, depressions in the plains and hills and, sporadically, on the mountain floor. Therefore, it has a well-developed native area between 40 and 50 ° north latitude in Europe, Asia Minor and Central Asia, completely covering the Black Sea Basin Area (see Fig. 2.11). In Romania, it is frequently found in percentages of over 50%, even over 75% in the South East Development Region in the Danube Meadow and the Danube Delta (European Atlas of Forest Tree Species, 2016).

It is a plant appreciated by bees for the nectar and pollen collection, especially in early spring and for manna in autumn, produced by the large lachnida.

Honey has a special flavor, it is light yellow-golden, with a production evaluated at 100-150 kg / ha in favorable years (Association of Beekeepers from RS Romania, 1986, p. 285; Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, pp. 173).

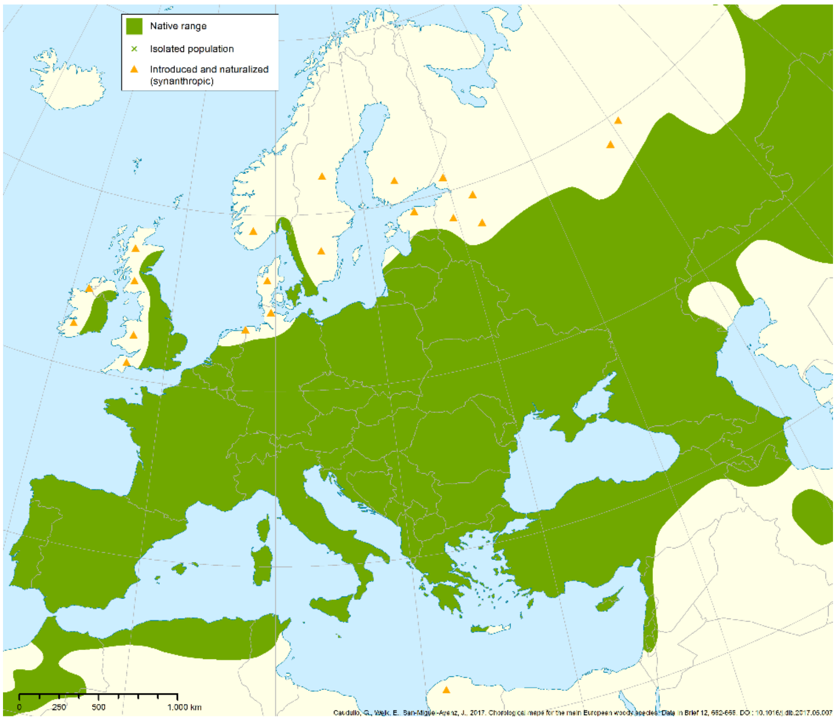

Fig 2.11 White willow *(Salix Alba)*

Source: Caudullo, G., Welk, E., San-Miguel-Ayanz, J., 2017. Chorological maps for the main European woody species. Data in Brief 12, 662-666. DOI: doi.org/10.1016/j.dib.2017.05.007.

2) Goat willow (Salix caprea L) is under the form of a tree or shrub with heights of up to 10 m, rarely up to 15 m. The trunk is small, up to 40 cm in diameter, the branches are thick and green, with gray hairs. The leaves are broad-elliptical, thick and up to 4-12 cm long, with a green and glossy upper part, and white-gray on the back (Florian Vizireanu, 2020).

The flowers bloom before the foliage, in spring (March-April) and are arranged in tassels: the male flowers are 2-4 cm long, attractively yellow for the bees and the female flowers are cylindrical, up to 6 cm (Florian Vizireanu, 2020).

It is a fast-growing species, native to Europe and Asia. The native area has a wide extension starting as far South as the 40th parallel North latitude on the European continent and Asia Minor and reaches up to the 70th parallel North latitude in the Scandinavian Peninsula (European Atlas of Forest Tree Species, 2016).

In the Black Sea Basin Region this native area appears on the territory of Turkey (in the Pontic Mountains), Bulgaria, Romania (only in the western extremity of the South-East Development Region with rugged relief).

It has an apicultural importance; the flowers are appreciated by bees for nectar and pollen collection in spring (which contributes to the keeping and development of bee families) and manna in autumn. The honey production is estimated to be 100-200 kg / ha.

2.2.2 TECHNICAL PLANTS CROPS

The expansion of some technical plants in crops, such as sunflower and rapeseed as a result of multiple uses (food, industry, medicine, animal husbandry, etc.), the crop technology that does not pose major problems to the grower, ecopedoclimatic conditions, etc. have given rise to new honey sources of very high and high economic and beekeeping percentages.

A) Sunflower

Helianthus annuus L. known by the common name of sunflower is native to North America (Mexico and USA), was brought to Europe in the sixteenth century, was firstly used as an ornamental plant and later began to be cultivated as a technical plant producing seeds for oil extraction.

It is an annual, herbaceous species, about 0.60 - 2.5 m tall, with a well-developed root system, with large pedunculated leaves, covered with rough hairs which enable resistance to drought.

Sunflower is a typical entomophilous plant, which has led to the emergence of many varieties and origins of the sunflower (differentiated by physiological and morphological properties) and therefore, in addition to productive features, it is characterized by a high honey value. It blooms in June-July; the blooming lasts about 3 weeks.

Among the climatic factors, temperature has a decisive role on the secretion of nectar, the others having more of a corrective role. The optimal temperature for an abundant secretion of nectar in sunflower is between 28 - 32° C. This was established based on scientific studies / research on the part of the Research-Development Institute for Beekeeping and the National Meteorological Administration of Romania (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, p 136). However, water reserves in the soil during September-April, as well as soil fertility are very important.

With a high seed oil content (40-50%), with the possibility of growing in different climatic conditions and increased adaptability, under conditions of advanced mechanization, production without major marketing problems and just as well being the most preferred vegetable oil in the

Eastern Europe, the Balkan and Black Sea region, sunflower is in the top of oil crops of these regions (Y. Kaya, 2020).

Currently, there are no cultivation problems in both Turkey and other Balkan countries. Nevertheless, in Ukraine (and Russia), there are large areas in climatically and pedologically different areas (Y. Kaya, 2020). Sunflower is a main crop in the rotation system of agricultural production, as well as one of the most cultivated technical plants for oil in these areas.

The sunflower cultivated areas in the countries bordering the Black Sea (1,000 Ha)

	2019	*2016*	*2013*	2010	2017
Ukraine	5849	6087	5090	4526	3411
Russia	8100	7294	6795	5575	5033
Romania	1010	1038	1095	810	830
Bulgaria	789	818	860	692	520
Turkey	695	718	630	500	475
Rep. of Moldova	330	361	275	252	230
Total surface in the BS coastal countries	16773	16316	14745	12355	10469
Total surface in the world	26260	26341	25892	23923	21305
Area in the countries bordering the Black Sea against the global surface cultivated (%)	63,9	61,9	56,9	51.6	49,1

Source: Kaya, Y. (2020). Sunflower Production in the Blacksea Region: The Situation & Problems. International Journal of Innovative Approaches in Agricultural Research, vol 4(1), 147-155

Ukraine has a significant share among the countries bordering the Black Sea in terms of the sunflower cultivated area and also the 5 regions of southern Ukraine, within the Black Sea Basin (see attached table), stand out because alltogether, they represent over 30 % of the total sunflower cultivated area of Ukraine. The Pontic Plain, the Volhino-Podolic Plateau, the Dnieper Plain, the Donets-Don Plateau and Plain meet favorable conditions of relief, climate and soil.

The area cultivated in Ukraine, including in the Black Sea Basin regions, with technical plants (thousand Ha)

Species:	Sunflower		Rapeseed (Win+Spr)		Rapeseed Winter		Rapeseed Spring		Mustard	
YEAR:	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
Total Ukraine	**6058,2**	**5849,3**	**1042,4**	**1285,4**	**974,0**	**1251,8**	**68,4**	**33,6**	**57,9**	**50,6**
Donetsk	309,1	308,1	21,3	32,1	16,9	31,7	4,4	0,4	6,6	4,8
Zaporizhzhya	554,6	527,5	32,4	70,2	29,9	68,7	2,5	1,5	8,7	7,7
Mikolayiv	544,3	488,0	39,4	87,4	37,6	85,7	1,8	1,7	1,4	1,2
Odesa	405,1	361,1	150,9	193,2	149,1	192,2	1,8	1,0	1,4	1,7
Kherson	335,3	342,6	63,4	88,5	60,8	86,3	2,6	2,2	15,0	12,1
Total Black Sea	2148,4	2027,3	307,4	471,4	294,3	464,6	13,1	6,8	33,1	27,5
Region (%)	35,5	34,7	29,5	36,7	30,2	37,1	19,2	20,2	57,2	54,3

[1] *Data exclude the temporarily occupied territory of the Autonomous Republic of Crimea*

Source: http://www.ukrstat.gov.ua/

In the top of the sunflower cultivated areas within the 8 development regions of Romania, there is the South-East Development Region which is framed by the Black Sea Basin and has been maintained in this position for more than 20 years, with values that have varied every year between ¼ and about 1/3 of the total cultivated area in the country (The National Institute of Statistics - territorial statistics) [3]. As it comes out in Fig 2.12, the sunflower areas within this region have been increasing, being in 2019 about 3 times more than in 1990. As in the whole country, this was due to the research carried out in Romania in several series of experiments, some with international collaboration within the Sunflower FAO Network, which highlighted the need to observe the important elements of an advanced crop technology (CSÉP NICOLAE, 2018).

The fluctuation of the values in the cultivated surfaces can be attributed, among others, to the fact that the increased surfaces raise the problem of the possibility in terms of applying the necessary crop rotation with view to preventing the occurrence of soil pathogens; crop rotation is a particularly important measure, the cultivation of sunflower on the same surface for several years is totally contraindicated (CSÉP NICOLAE, 2018).

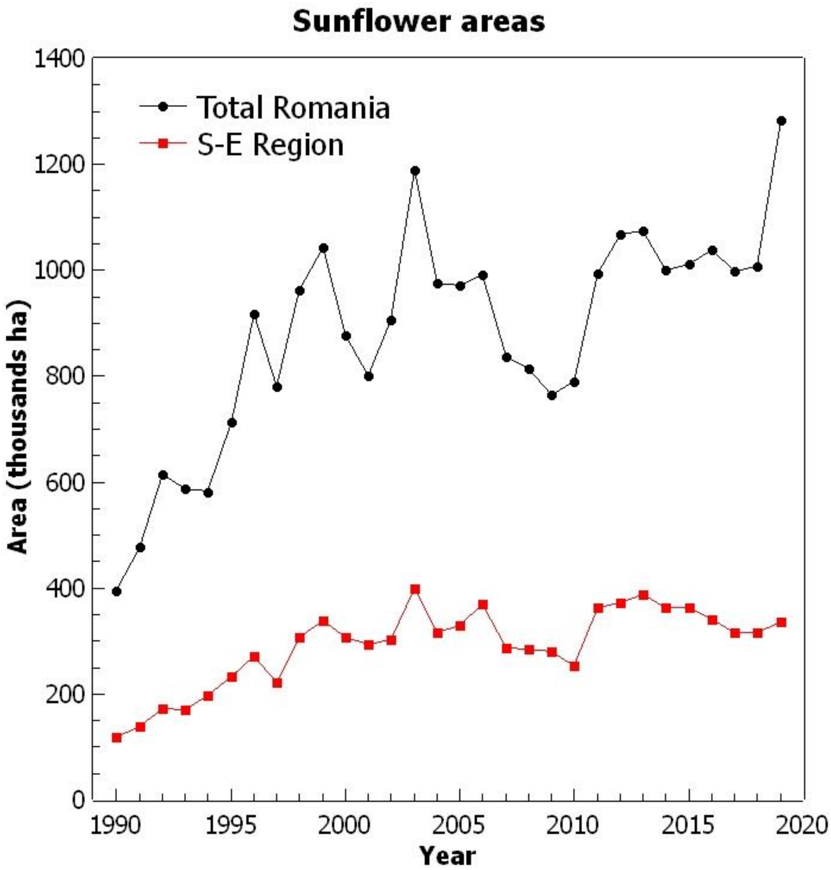

Fig. 2.12 Sunflower cultivated areas
Source: http://statistici.insse.ro

Taking into account the soil and climate conditions in the sunflower crop regions in Romania in relation to the requirements of this species, 6 ecological zones were established according according to the degree of suitability to this crop, namely: 1st zone - very favorable area;

[3] http://statistici.insse.ro/

2nd zone –favourable area; 3rd zone – less favorable area; 4th zone - hardly favorable area; 5th zone – complex area and 6th area, unsuitable area for sunflower crops (Vasile Alexandru et al., 1986, p.290). Particularly important for beekeeping are the sunflower crops from zones I and II, because the nectar secretion of the sunflower is good and the production of honey is high every year (Vasile Alexandru et al., 1986, p.290); in the 1st zone, the amount of the temperature degrees reaches about 2600° C, the precipitations reach over 300 mm during the vegetation period, the soils are fall in the category of chernozems, alluvial soils; in zone II, the sum of the temperature degrees is between 1800 and 2000 °C, the soil conditions are different in fertility, structure and texture, from chernozems to podzols.

*Fig. 2.13 The 1st photo (*July 2020) – the apiary of a beekeeper in the Black Sea Basin network, located in the Danube meadow (Tichilești, Brăila county, Romania) for sunflower harvest;

Foto 2 (July 2020) – moment captured in the presentation of sunflower features according to sex during a field visit (a project activity) to the above-mentioned apiary

Consequently, the South-East Development Region of Romania is exactly within the ecological zones I and II, being therefore an important beekeeping area in Romania based on this this entomophilous plant. Also, the research undertaken a few years ago by the Research-Development Institute for Beekeeping in Romania has revealed the great variability of the nectar production determined by variety, pedoclimatic conditions and the evolution of time / weather (Vasile Alexandru et al., 1986, p .290) In the Republic of Moldova, the cultivated area has been increasing since 2009, of the 3 regions, the Northern one stands out clearly from the others (see Fig. 2.14).

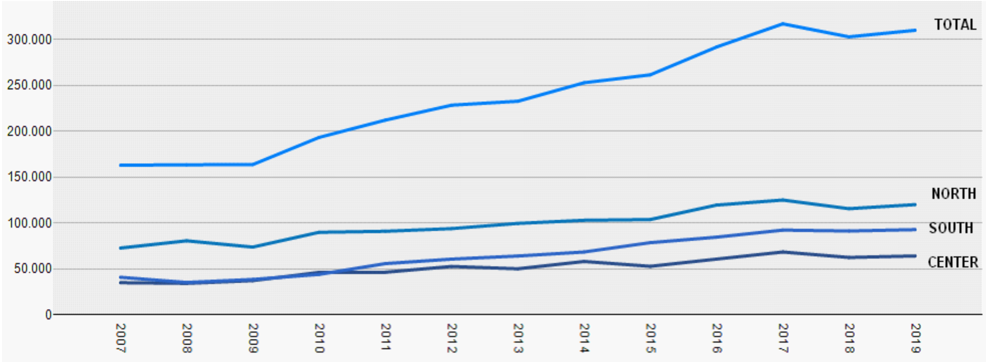

Fig. 2.14: *The sunflower cultivated area (ha) (in agricultural enterprises and households) in the Republic of Moldova, depending on regions and years*
Source: The National Bureau of Statistics; https://statistica.gov.md/

In Turkey, the Trakya Region is the main area of sunflower production, which has over 50% of the total cultivated area and of the production (Yalcin KAYA, 2014). It is framed by the Black Sea Basin, representing the European part, with lower forms of relief (plains vat the base of mountains, with an altitude of about 100-300 m, slightly sloping and hills and low mountains about 200-1200 m) and ecopedoclimatic conditions suitable for this crop. Turkey is mainly an importer of sunflower seeds from Romania, Bulgaria and the Republic of Moldova (Yalcin KAYA, 2014).

In Bulgaria, due to the higher export demand, especially to Turkey, sunflower production reached a record close to 2 million tonnes in 2013 due to both increased cropland and the appropriate climatic conditions during the growing season (Yalcin KAYA, 2014). It is cultivated in the plains (both low, poorly fragmented, and on foothills up to about 300 m) and hills in the Black Sea Basin area.

In Romania, it has been proven that under favorable conditions, sunflower crops can provide bee families with constant harvests with a honey production estimated at 34-130 kg / ha, the nectar secretion is 0.16-0.373 mg / flower and has a concentration of sugar of 55-69% (Petre Iordache, Ileana Roșca, Mihai Cismaru, 2007, p.138). The honey is yellow, straw-yellow or yellow-brown.

In order to increase the honey production, it is necessary to choose the location well so that the worker bees visit 2-3 plots of land with different flowering periods. Pentru creșterea producției de miere este necesar să se aleagă bine locul de amplasare încât albinele lucrătoare să viziteze 2-3 sole cu perioade de înflorire diferite.

B) Rapeseed

1)*Brassica napus oleifera L*, under the common name ***rapeseed/*** **autumn rape** (in Romania) ***/winter rape*** (in Ucraine) is an annual herbaceous species, cultivated as an oleiferous plant due to the high oil content of the seeds. It is up to about 160 cm tall, with a branched stem, the leaves are glabrous, misty, greenish-blue, the flowers are yellow, with entomophilous pollination, grouped in elongated racemes.

It blooms in spring, in April - May, as a good opportunity for bee families when the honey supply is still quite low, for a period of about 30 days; the flower stalks usually have three stages of flowering and on each row, the flowers secrete nectar and pollen for 8 consecutive days, so it can be said that the rapeseed bloom lasts for 24 days, but the fourth flower cluster can appear, prolonging the flowering up to 32 days only in conditions with temperatures above 25 ° C and moderate rainfalls (Petre Iordache, Lumea Satului; Florian Vizireanu, 2020).

Rapeseed as a honey plant begins to provide bees with light yellow pollen at 9 ° C and nectar at 14 ° C (Petre Iordache, Lumea Satului).

Rapeseed nectar contains a substance called querticin, which in the opinion of Prof. Dr. Gheorghe Mencinicopschi, head of the Romanian Food Research Institute, "quercetin is a powerful antioxidant flavonoid, with a role in fighting circulatory disorders, cardiovascular disease and even cancer. Other studies have shown that quercitin can slow down or even stop the degeneration of brain cells that can cause, among other things, the onset of Alzheimer's disease and that the consumption of this substance also stimulates the body's immune systems (Petre Iordache, Lumea Satului).

Rapeseed has been cultivated since ancient times by the peoples around the Mediterranean Sea and the Middle East. It adapts to moderate humidity and an amount of average daily positive temperatures of 2100-2500 ° C. Alternating frosts and thaws as well as late frosts, which appeared in the budding and blooming phase, partially or totally compromise the crops.

The quantity of honey obtained from rapeseed harvests is estimated at 40/50 kg / ha - 100 kg / ha (Florian Vizireanu, 2020).

2) *Brassica rapa oleifera L* or the common name of **small rapeseed */spring rapeseed*** is an herbaceous species, annual or biennial, existing in the wild.

It is cultivated for the extraction of vegetable oil from its seeds; it is sown in early spring. Spring rapeseed cultivation is profitable especially when it is not possible to cultivate autumn / winter rapeseed due to unfavorable climatic conditions, giving high yields / ha and on gley and pseudogley soils (Ferma, 2011).

It has a 30-40 / 100 cm branched stem, the flowers are bright yellow, grouped in umbella-shaped racemes that bloom between April and May. It belongs, like the autumn / winter / sea rape, to the category of honey plants with a high economic-bee weight; the amount of nectar 0.1-0.5 mg mg / flower (Petre Iordache et al; 2007, p 72).

Rapeseed has started to gain more and more ground in the last 10/15 years, because good quality oil and biodiesel oil are obtained. The latest crop technologies in the field, but also the emergence of hybrids allow successful cultivation in Ukraine, Romania, Republic of Moldova.

Farmers prefer autumn / winter rapeseed to spring rapeseed, which is why the cultivated areas are more extensive.

The Republic of Moldova and the regions of the Black Sea basin in Ukraine, Romania and Bulgaria are favorable to rapeseed crops.

For example, in Ukraine, in the last 2 years (2018 and 2019) the regions of the Black Sea Basin have registered each year, an area cultivated with rapeseed (the winter and spring sort) of about 30% out of the total area cultivated with rapeseed in Ukraine; in these regions the area with winter rape crops was 30% of the total area cultivated with winter rape in Ukraine, the Odessa region being the most conspicuous and the area with spring rape was about 20% of the total area cultivated with spring rape in Ukraine (see table above - *Area cultivated in Ukraine, including in the regions of the Black Sea Basin, for technical plants (thousand Ha).*

In the Republic of Moldova in the last 2 years (2018 and 2019) the areas cultivated with rapeseed returned to the level recorded in 2007, 2010 and 2011, but lower than in 2008 and 2009; in the North and South regions, it is cultivated much more than in the Center Region (Fig. 2.15).

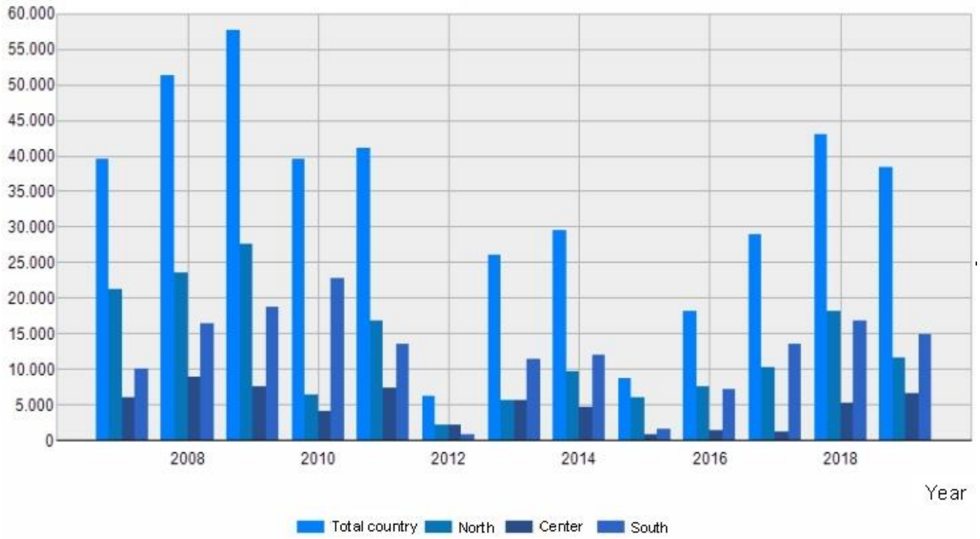

Fig 2.15 The rapeseed cultivated surface (ha) (in agricultural enterprises and farms) in the Republic of Moldova, per regions and years
Source: National Bureau of Statistics; https://statistica.gov.md/

In Romania, the area cultivated with rapeseed has started to increase a lot since 2006 both at the level of the entire country and at the level of the South East Development Region, participating with about 20-30% of the total rapeseed cultivated area in the country (Fig. 2.16).

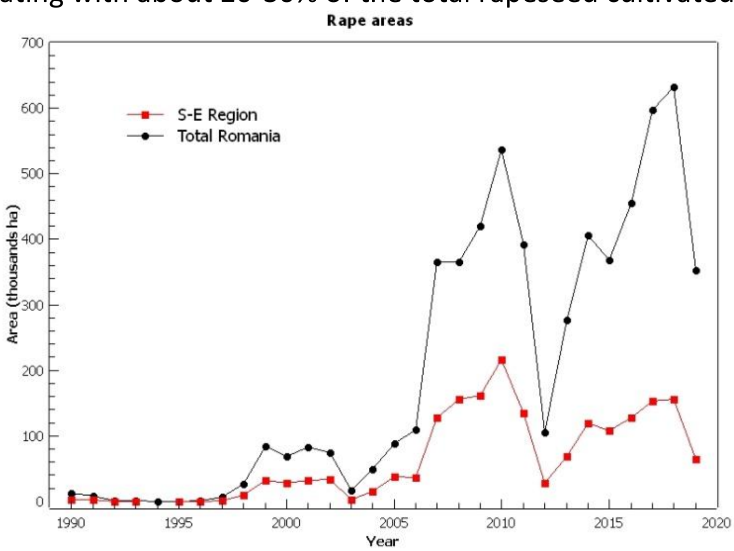

Fig. 2.16 *Rapeseed cultivated areas*
Source: http://statistici.insse.ro

C) Mustard

1) *Brassica alba* or the commonly known ***white mustard*** is an annual species, it is cultivated mainly for seeds with a high oil content or as a raw material for obtaining mustard spice.

The plant is nectariferous and polleniferous, it blooms about 40 days after sowing; in dry weather, the nectar secretion decreases greatly or ceases. White mustard crops can provide staggered sources of harvest from spring to autumn, thus completing the honey resources, because it has a short vegetation period.

The average honey production in usual years is about 40 kg / ha.

2) *Brassica Nigra* or the **black mustard**, is an annual species, with a stem up to about 150 cm high, sensitive to frost and drought, which is cultivated for its oil-rich seeds.

Black mustard crops provide maintenance harvests for bee families.

The Western and Northwestern regions of the Black Sea basin are favorable for mustard crops. For example, the regions of Ukraine included in the Black Sea Basin represent about 55% of the total area of the country cultivated with mustard (see the previous table - *The rapeseed cultivated surface in Ukraine, including in the regions of the Black Sea Basin, for technical plants (thousand Ha).*

2.2.3 FORAGE CROPS

Forage crops improve the honey resources in the growing areas, in addition to the direct advantage of the natural food needed to feed the animals.

a) **Alfalfa** or **lucerne** (*Medicago sativa* in the binomial nomenclature) a herbaceous, perennial species with a well-developed root system giving resistance to drought. The floral conformation is typical of leguminous – papilionaceae plants, enclosing in the hull (corolla) the stamens and the pistil (Romanian Beekeepers Association, 1986, p. 294). Flowering takes place twice a year, in spring and late summer - early autumn. The estimated honey production reaches up to 200-250 kg / ha. In Romania, the cultivated area has increased in the recent years, but in the South-East Development Region, it remains at the same values (see Fig. 2.17), representing about ¼ of the total country.

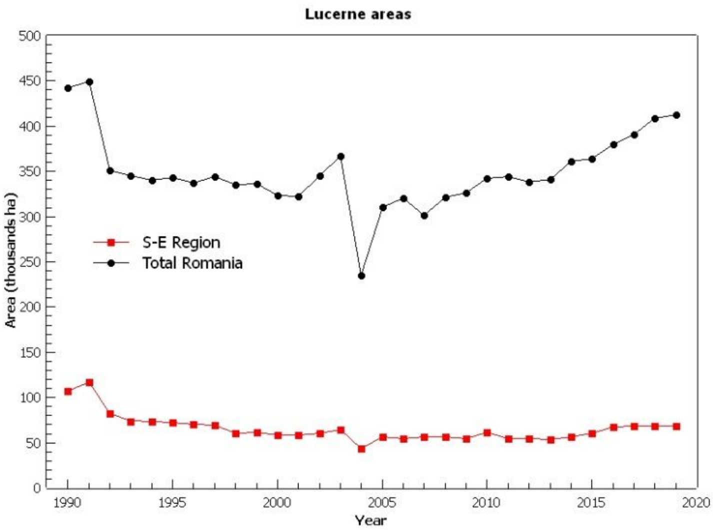

Fig.2.17: Alfalfa cultivated areas, Source: http://statistici.insse.ro

b) Several species of **clover** are to be found in the Black Sea: red clover (*Trifolium pratense*) – a perennial plant that grows spontaneously or cultivated; the white clover (*Trifolium repens*) – a perennial plant; the hybrid clover (*Trifolium hybridium*) - prefers soils with a lot of moisture, etc. The clover generally blooms from May to September. The estimated amount of honey can reach about 400 kg / ha, but depending on the species.
In Turkey, clover is one of the most important honey plants due to its abundant nectar and quality honey. It is found on the stony slopes, in areas with meadows and steppes up to heights of about 2000 m, as in Zonguldak, Gümüșhane etc.
In Romania, the cultivated area at the level of the South-East Development Region is very small (see Fig 2.18) compared to the total area per country.

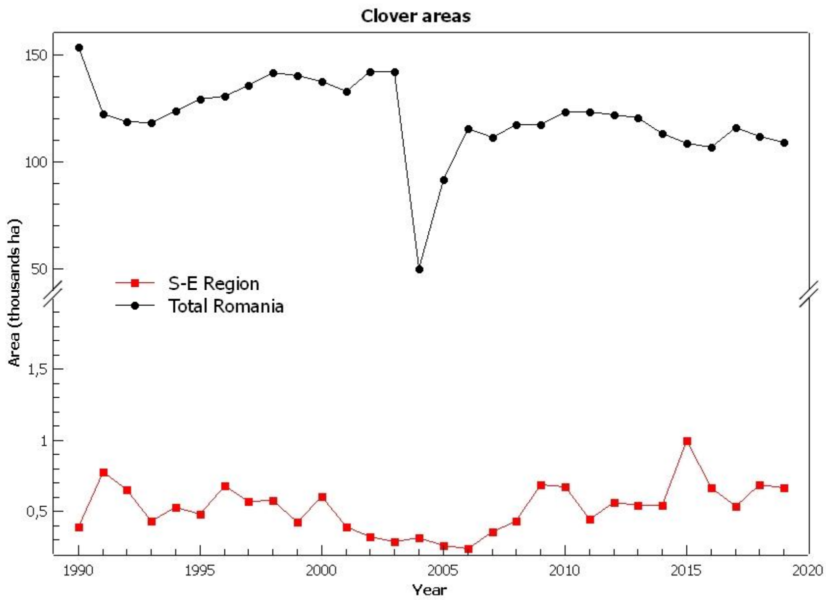

Fig. 2.18: Clover cultivated surfaces
Source: http://statistici.insse.ro

c) Other plants in this cathegory**:** sparceta (*Onobrychs viciifolia),* white melliot (*Melilotus albus*), spring vetch (*Vicia sativa*).

2.2.4. MEDICINAL AND AROMATIC PLANTS

a) The **American Mint** or the fragrant nettle, has the scientific name of *agastache foeniculum lophanthus* and is a species that originally comes from central North America. This honey plant is part of the lamiaceae family, Agastache genus. This genus comprises a total of 22 species from North America. The American mint blooms for a long time, between June and October, has small, tubular flowers that are arranged in spikes of 4-8 cm, blue, purple, pink or white, which emanate a strong smell of mint, anise and lavender. A single plant can produce seeds to grow one acre, 90,000 flowers. One gram of seed contains over 1000 seeds. Its leaves resemble those of dead nettle or lemon balm, having a dark green color (Zielińska et al., 2014).

At the same time, this plant has a special beekeeping importance, in North America being considered one of the most important plants for pollinators, being visited by wild bees, honey bees, butterflies, bumblebees and other pollinators. It is believed that half an acre cultivated with this honey plant can support over 100 bee families, and aniseed-flavored honey is highly valued by the Americans.

In Europe, this honey plant was introduced by beekeepers. In some regions of Europe, (even Hungary), it grows wild. In Romania, Lophanthus anisatus was studied at the Buzău Vegetable Products Research and Development Station, where in 2015, varieties of seeds acclimatized to the specific climate and soil conditions of the Romanian area, have been obtained. Thus, following the research carried out at the vegetable station in Buzău, a melliferous potential of 500 kg of honey per hectar and a vegetal production of 22 tons of plant have been estimated, subject to the conditions of a need of 250-350 m3 of water per hectar (Vînătoru și colab., 2015). Data from beekeepers about its honey potential in Romania in the scientific literature are not known as most beekeepers prefer the spontaneous flora. An economically viable aeroponic model of intensive beekeeping could be an economic motivation that would arouse beekeepers' interest in this honey plant, given that 1 kg of such honey is sold on the US market for $ 100. Lophanthus anisatus has a high resistance to diseases and pests, the pH of the substrate is recommended to be 6 - 6.5. We found that Lophantus anisatus is resistant to low winter temperatures. The plant enters the vegetation stage since winter on the background of global warming.

b) **Other plants** that belong to this category: pepermint (Mentha piperita), thyme (Thymus vulgaris), lemon balm (Mellisa officinalis), sage (Salvia officinalis), lavender (Lavandula vera sin. L. Officinalis), fennel (Foeniculum officinale), garden poppy (Papaver somniferum), oregano (Origanum vulgare - L.).

Figure 2.19: Asian mint of Lophanthus Anisatus species, October 2019

2.2.5. TABLE OF HONEY PLANTS

The species of honey plants in the Black Sea Basin Region are reserves of nectar and pollen for bee families, some of them providing important annual production harvests.

The attached table shows a summary of honey plants in this region, a general picture according to the basic species.

	Plants important by geographical distribution and recognized by the economic-beekeeping share (very high and high), representing the main or maintenance harvests					
	Honey Plant					
	Country / regions	**Species name (Latin name)**	**Biological data** (A - arbot; s- shrub; h- herbaceous; an – annual; bn- biennial, pr – perennial; ct- cultivated, sp- spontaneous, n- nectareous, p- polllen; m- manna; g – glue / propolis)	**Flowering period (months)**	**Flowering time in optimal conditions**	**Honey production evaluated in favorable years (kg / ha)**
1	**Romania / South-East Development Region**	White acacia (Robinia pseudoacacia L) – main harvest	A.n.p.m	May-June	8-12/14 days	800-1200
		Silver lime (Tilia tomentosa M) – main harvest	A.n.p.m	June-July	7-12 days	1200
		Large leaf lime (Tilia platyphyllos Scop) – main harvest	A.n.p.m	June-July	8-15 days	800
		Small-leaved lime (Tilia cordata Mill) - main harvest	A.n.p.m	June-July	8-12 days	1000
		White willow (Salix alba) more maintenance picking	A.n.p.m	April - May	14-20 days	100-150
		Sun flower (*Helinathus annuus L* – main harvest	h.an.ct.n.p.m.g	June-August	20-25 days	34-122
		Large rapeseed / autumn rapeseed (*Brassica napus oleifera L.)*	h.an.ct.n.p	April- May	45 days	40-100
2	**Bulgaria** / Severoiztochen, Yugoiztochen	Silver lime /Tilia tomentosa M	A.n.p.m	-	-	-
		Large leaf lime /Tilia platyphyllos Scop	A.n.p.m	-	-	-
		Small-leaved lime /Tilia cordata Mill	A.n.p.m	-	-	-

		White acacia / Robinia pseudoacacia L	A.n.p.m	-	-	-
		Acer campestre L	A.n.p.m	April	Peste 20 days	cca 1000
		Sun flower/Helinathus annuus L	h.an.ct.n.p.m.g			
3	**Turkey** /TR10 (İstanbul), TR21 (Tekirdağ, Edirne, Kırklareli), TR42 (Kocaeli, Sakarya, Düzce, Bolu, Yalova), TR81 (Zonguldak, Karabük, Bartın), TR82 (Kastamonu, Çankırı, Sinop), TR83 (Samsun, Tokat, Çorum, Amasya) and TR90 (Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane)	Acacia *Robinia pseudoacacia* L.	Prennial tree-Source of Pollen and nectar	April-June	8-15 days	1500
		Linden *Tilia argentea* L.	Prennial tree-Source of Pollen and nectar	May-July	8-15 days	1000
		Sunflower *Helianthus annuus L*	Bedding plant cultivar – Source of pollen and nectar	July-August	25-30 days	800-1700
		Chestnut *Castanea sativa*	Prennial tree-Source of pollen and nectar	June-July	10-25 days	100-150
		Heather *Calluna vulgaris*	Prennial plant-Source of pollen and nectar	August-October	30-35 days	200-250
		Canola *Brassica napus L*	Bedding herbaceous plant-Source of pollen and nectar	April-May	30-40 days	40-120
		Echium vulgare *Echium vulgare .L.*	Bedding or allioni plant-Source of pollen and nectar	May-September	15-20 days	300-400
		Agnus castus *Vitex agnus-castus . L.*	Prennial or brier plant-Source of pollen and nectar	June-September	15-20 days	100-200
		Lavender *Lavandula stoechas*	Brierpatch plant-Source of pollen and nectar	June-July	30 days	150-300
		Astragalus glycyphyllos *Astragalus stevenianus*	acanthous and herbaceous plant-Source of pollen and nectar	May-June	20-25 days	50-100
		Thyme *Thymus serpyllum*	herbaceous plant - Source of pollen and nectar	June-October	25-40 days	50-100
		Sage *Salvia glutinosa L*	Perennial plant-Source of pollen and nectar	May-July	15 days	80
		Paliurus *Paliurus spina-christi*	Perennial or brier plant-Source of pollen and nectar	May-July	15 days	150-400
		Oak *Quercus robur L.*	Tree-Source of nectar	August-September	10-15 days	50-100

		Napoleon *Trifolium pretense*	Perennial cultivar plant-Source of pollen and nectar	April-August	15-20 days	100
		Rhododendron *Rhododendron ponticum L*	Perennial indeciduous brier plant-Source of pollen and nectar	May-June	20 days	50-200
		Medic *Onobrychis sativa*	Perennial herbaceous plant-Source of pollen and nectar	April-June	25-40 days	90-400
4.	**Republic of Moldova**	White acacia Robinia pseudoacacia	A.n.p.m	May-June	8-12 days	900-1500
		Large leaf lime Tilia platyphyllos Scop	A.n.p.m	May -June	8-15 days	800
		Small-leaved lime Tilia cordata Mill	A.n.p.m	June	8-12 days	1000
		Silver lime /Tilia tomentosa M	A.n.p.m	June-July	7-11 days	1200
		White willow Salix alba	A.n.p.m	April - May	14-20 days	100-200
		Sun flower *Helinathus annuus L*	h.an.ct.n.p.m.g	June-July	2-3 weeks	30-120
		Rapeseed /*Brassica napus oleifera L.*	h.an.ct.n.p	April- May	30 -45 days	35-100
		Tartarian Maple / Acer Tataricum L	A.n.p.m	April – May	over 10-14 days	300-600
5.	**Ukraine**/ Odesa, Mykolaiv, Kherson, Zaporosh'ye and Donetsk Oblasts, Crimea Republic, Sevastopol	White acacia/ Robinia pseudoacacia L	A.n.p.m	May-June	8-10 days	until 1000
		White willow/ Salix alba	A.n.p.m	April - May	14-20 days	100-150
		Yellow acacia (caragana tree)/ Caragana arborescens/ Карагана дерев'яна яниста, жовта акація	s. n.p.m	June -Julay	13 days	150-350

		Rapeseed /Brassica napus/ Ріпак, свиріпа	h.an.ct.n.p	April - May	40 days	35-100
		Sun flower/Helinathus annuus L/ Соняшник	h.an.ct.n.p.m.g	June-July	31 days	45
		White mustard/ Sinapis alba/ Гірчиця біла	h.an.n.p	April-June	24 days	40-50
		Small-leaved lime /Tilia cordata Mill/ Липа серцелиста	A.n.p.m	June	11 days	800

Sources:
- Eastern Black Sea Development Agency, Turkey
- Mycolaiv Regional Chamber of Commerce and Industry, Ukraine; the selection and characteristics of honey plants was made based on the information provided by this institution;
- Petre Iordache, Ileana Roșca, Mihai Cismaru, Honey plants of very high and high economic-apicultural share, Bucharest, 2007
- Modvala Susana, Improving the technology of pastoral beekeeping, doctoral thesis in agricultural sciences, State Agrarian University of the Republic of Moldova, Chisinau 2018, pp. 32, 54, 57.60, 66; http://www.cnaa.md/files/theses/2018/53716/11.06.18-final-teza,-susana.pdf

Note: ”-” missing data

Chapter 3 . CLIMATIC CONDITIONS

3.1 CLIMATE GENETIC FACTORS

The climatic conditions within the Black Sea Basin Region are determined by a series of factors whose weight vary either from one state to another or within the basic administrative-territorial units / development regions of the same state. But, of all the factors, the decisive role is played by solar radiation.

3.1.1 Radiative climatogenic factors

In the temperate zone, the average annual values of global radiation vary between 140 kcal / cm^2 and 80 kcal / cm^2 (Sterie Ciulache, Nicoleta Ionac, 2007, p. 128). The Black Sea Basin region is located between the 40th and the 48th parallels North latitude, so that the distribution of average annual values of solar radiation is 140 kcal / cm^2 / year in its South and 100 kcal / cm^2 / year in the North. Starting with the European part of Turkey and continuing on the territory of Bulgaria, the values decrease, reaching 120 kcal / cm^2 / year in the Northeast of the Bulgarian coast.

However, in a predominantly sloping unit, the degree of the surfaces proclivity is a decisive factor that the amount of solar radiation received by the areas with the same orientation, depends on. For example, in the vicinity of the 45th parallel North latitude, in the Southern part of the Curvature Subcarpathians of the South-East Development Region (Romania), the average value of the solar radiation of about 120 kcal / cm^2 / year is registered.

On an annual basis, at the level of the entire sea basin, the lowest average monthly amounts of global radiation are recorded in December (the month of the winter solstice, with the lowest angle of the Sun's height above the horizon and the highest nebula), and the highest, in July (with still higher altitudes of the Sun and low cloud cover).

3.1.2 Physico-geographical climatogenic factors

A) The climatogenic role of the relief

The relief represents not only a material support, but it also has a climatogenic role (Sterie Ciulache, Nicoleta Ionac, 2007, p. 131). Climate / topoclimate types influence honey plants (distribution, structure) and honey production, as well as other bee products.

By its way of action - altitude, fragmentation, the degree of inclination of the land, the exposure of the slopes - the relief influences the circulation of the atmosphere and brings substantial changes in the climatic parameters system such as temperature, humidity, precipitation.

The morphometric characteristics bring out important differences at the level of each large relief unit.

In hypsometric ratio, the Black Sea Basin Region runs between the level of the Black Sea and the mountain peaks of the alpine folding system with altitudes over 1500 m on the territory of Romania (Eastern Carpathians – curving area) and Bulgaria, over 1900 m on the territory of Turkey (Western Pontic) and even 3000 m also on the territory of Turkey (West Pontic- Vf Kaçkar of 3932m).

The share of relief steps differs from one country to another by the regions covered as follows: below 200 metres is the altitude including most of the regions of Ukraine (about 90%), then about 60-70% of the total area Republic of Moldova and Romania, followed by Bulgaria and at least Turkey (about 15-20%); over 200 metres, the situation is exactly the opposite, that is the largest area is held by the regions of Turkey and the least by the regions of Ukraine. It turns out that on the whole, the Black Sea Basin Region is one of contrasts: the low dominant relief (plains, plateaus / hills) in the northwestern part of the Black Sea and the dominant high relief in the southern Black Sea.

Altitude has the strongest differentiating effect, acting on all the characteristics of the climate and, implicitly, in the distribution of the vegetal carpet and the types of soil. As the height increases, the air temperature decreases, precipitation increases, etc. and as a result, there are changes in the structure of the vegetation and pedogenesis conditions in the temperate zone, so that vegetation layers and soil types are formed under successive areas from the base to the top. Usually, first the deciduous and then the coniferous succeed each other at high altitudes. Only where frequent thermal inversions occur (night and winter in anticyclonic regime) by the accumulation of cold air in the lower parts of the mountain relief, do vegetation inversions occur, which makes coniferous forests take the place of deciduous ones (for example in the Eastern Carpathians , the area of curvature).

Through altitude and exposure to air circulation, the relief strongly influences the precipitation regime, generally, the amount of precipitation increases in parallel with the increase in altitude, a rule valid under certain conditions and within certain limits within the Black Sea Basin. For example, the Pontic Mountains to the South of the Black Sea act as an orographic barrier to air masses in the North and Northeast, which leads to an increase in the average annual rainfall due to the general circulation of air masses from the West. (over 1500 mm / year) favoring the further development of pine and deciduous forests.

Also, the Caucasus Mountains in the Eastern Black Sea amplify the rainfall regime, making the TR90 region (Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane) to be the rainiest; The average annual rainfall in Rize and the surrounding regions is more than 2,000 mm.

The relief fragmentation is entailed by the set of valleys in each relief unit, so that the slopes by way of proclivity, shape, length, exposure to the sun influence the climatic parameters and also the degree of land use (presence of natural vegetation, agricultural crops).

Of all the relief levels, the mountainous regions have a high degree of fragmentation, the Pontic Mountains being the most conspicuous with the largest deployment from West to East (as well as the general circulation of air masses), along the Black Sea, with a dense hydrographic network, generally parallel and tributary to the Black Sea, which generated mostly, a system of parallel peaks.

This aspect makes the Western and Northern slopes record higher amounts of precipitation and slightly lower temperatures than those in the east and southeast, favoring, as we have already mentioned, the development of forests and pastures and hayfields. Also, the shape of the slope will be reflected especially in the diurnal amplitude of air and soil temperature, which will be lower on convex surfaces than on the concave surface (Iuliana Armaș, Răsvan Damian, 2001, p. 82); narrow and deep valleys will lead to thermal inversions and a channeling of cold air on their bottom.

On the next level of relief (hills and plateaus), as the degree of fragmentation, that is correlated with increasing temperature and decreasing rainfall, decreases, the share of arable land with cultivated plants increases (decreasing the share of forests and pastures and hayfields), including honey plants. Large areas cultivated with fruit trees, dominate the deciduous forests. For example, in the South-East Development Region of Romania, the South Dobrogea Plateau is recognized by large areas of sunflower, and the Curvature Subcarpathians by plantations of fruit trees and secondary meadows that contain honey species in their floristic composition (which is an attraction for some beekeepers in the Black Sea Basin network).

In the plain regions (such as the Romanian Plain, the Black Sea Plain on the territory of Ukraine), being poorly fragmented, the fields have a special expansion, receive almost uniform heat and precipitation, are intended in terms of land use, mostly to cultivated plants (specific geographical unit) considering the mechanization of agriculture is easy.

The modification and spatial distribution of the climatic elements as a result of the relief, the way in which they interfere with the particularities of the pedological and vegetal cover create at the level of the main relief stages, a specific productive natural honey potential.

Moreover, the interrelationship between altitude and temperature determines the natural limits (thermal thresholds) of extension in altitude of the area of different honey plants. These limits are not the same everywhere, they vary depending on latitude, the position of the mountainous or hilly massif within the Black Sea Basin, sun exposure, anthropogenic intervention (see maps of lime, pine, etc.).

Also, the density of the fragmentation of the relief determines an intensification of the exposure effects and of the degree of shading of the slopes in the general distribution of the vegetal carpet. Thus, the slopes with Southern and South-eastern exposure are more sunny and usually with lower degree of vegetation coverage than the slopes with Northern and North-western exposure with high humidity. But an important role is played by the ecopedoclimatic conditions preferred by certain species of honey plants from the same genus / family. This explains, for example, the presence of large areas of linden trees (silver lime, large-leaved lime, small-leaved lime) on the shady and sunny slopes of North Dobrogea, where the altitude is below 400 m. Sometimes the degree of increased sunshine and slope induce changes in the local characteristics by the frequent appearance of thermophilic species creating differentiations from areas with the same altitude and latitude. The Tartar maple (Acer tataricum) is common in the forests of downy oak and Oriental hornbeam in the Curvature Subcarpathians (Lucian Badea et al., 1992, p. 200), a nectariferous, polleniferous and manna plant, with a honey production of 300-600kg / ha.

Slope exposure is important in crop location because the plant requirements for light and heat are differentiated. The microclimate of the slopes with Southern exposure favors the extension of the cultivation area of some honey plants beyond the usual latitudinal limit.

The relief influences the substantial change of the direction and speed of the general circulation winds due to the altitude, the generation of katabatic winds (like the föhn) and the formation of periodic local breeze-type winds – both mountain and marine winds (Sterie Ciulache, Nicoleta Ionac 2007, p. 133). It has implications for the zonal / local development of beekeeping.

B) Black Sea – climatogenic factor

The Black Sea is a semi-enclosed sea, a component of the Mediterranean Sea, and which is, in turn, a fundamental type of active surface without neglectable influences on the genesis of the climatic conditions of the entire basin region, through different heating and cooling manner, by the fact that it is a permanent source of evaporation, through the changes it brings to the atmospheric pressure and wind characteristics, nebulosity and precipitation, etc.

The geographical location between 27 ° and 41 ° longitude places the Black Sea in the way of the air masses affected by the main baric centers: the subtropical anticyclone of the Azores, the continental Eurasian anticyclone, the cyclones of the North Atlantic and the Mediterranean (Emil Vespremeanu, Mariana Golumbeanu, 2018, p 136).

As a result of this position, the climate of the Black Sea presents (Emil Vespremeanu, Mariana Golumbeanu, 2018, p. 5, 60, 61):

- a semi-dry character with an evaporation of 300–400 km3 / year and an amount of precipitation of only 225–300 km3 / year on a large part of the basin surface;
- a distribution of the average annual surface water temperature during winter increasing from Northwest to Southeast of the waterbed: from about -1 ° C to 7 ° C along the shores of Ukraine, between 5.1-6 ° C near Romania, between 6.1-7 ° C near Bulgaria and between 7.1 and about 9 ° C along the coast of Turkey;
- an average annual surface water temperatures during summer between about 21 ° C (in the Odessa Gulf area) and over 26 ° C in the south - Southeast of the basin, near Turkey;
- a cooling of the surface waters starting from autumn with the North-Western corner (Fidonisi bay area) where in September, the average temperature is about 18 ° C which continues towards the South-East corner where it reaches around 21.2 ° C average temperature also in September.

However, the proximity of such a large aquatic area and its climatic characteristics does not remain without consequences on the continental climate, even if they are diminished due to the predominance of the Western circulation, characteristic to the middle latitudes.

Nevertheless, the thermal heterogeneity of the surface of the North-Western part of the basin generated by the flow of water (Danube, Dniester, Dnieper), the depth and configuration of the shore, as well as the predominant cold and dry winds that blow from the Northeast, accentuate the differences between the parameters of the continental climate in Ukraine and Romania, compared to the continental climate of Turkey near the Southeastern part of the basin (with lower average thermal aplitudes between winter and summer); in the continental space in the Northwest of the water basin, the springs are colder and the autumns are longer in the South-Southwest.

3.1.3 Dynamic climatogenic factors

These factors are represented by the general circulation of the atmosphere and the local, periodic and non-periodic winds (Sterie Ciulache, Nicoleta Ionac, 2007, p. 136).

The Black Sea Basin region is located in the temperate zone of the Northern hemisphere where Westerly winds are prevailing. They are intensely disturbed by the overall extent of the land (Europe and Asia) and by the higher and more rugged continental relief. The decrease in the influence of air masses from the West is felt more through the average annual values of precipitation and temperature which indicate a accentuated continentalism west and northwest of the Black Sea (Eastern European continent).

The presence of the Black Sea and the mountainous area attracts the formation of periodic local winds and precisely because of the thermobaric contrasts generated by the different way in which the neighboring active surfaces with distinct characteristics are getting warm during the day and cool at night – the sea and the land in case of sea breezes or the bottom of the valleys and the slopes in case of mountain breezes.

Except for the Republic of Moldova, all other countries have areas where sea breezes are felt (up to about 3-40 km inland, but depending on the configuration of the terrain), accentuated in the warm season. Usually, in their case, the air temperature is quite moderate, the breeze attenuating the temperature on the shore compared to the inland; at night, the land breeze reduces the air temperature as compared to the sea breeze, so that the thermal differences can rise to a few degrees (Sterie Ciulache, Nicoleta Ionac, 2007, p.145). It is a nice weather in day time (due to the downward and upward currents) and rainfall on the coast accompanied by breeze often fall during the night. In the coastal area the beautiful weather in general, especially in the warm season (May-September), clear weather and low cloudiness favor more beekeeping due to deciduous forests (linden, acacia) and agricultural crops (rapeseed, sunflower), therefore advantaged in this respect (and by the configuration and altitude of the relief) are the regions of Bulgaria, Romania, Ukraine and the European part of Turkey. Elements of subtropical vegetation appear on the Eastern edges of the Balkan Peninsula, as far North as the Black Sea coast of Bulgaria; above the subtropical vegetation, deciduous forests develop, consisting of oak, alder, linden, etc. (see the map of linden spread).

In the case of mountain breezes (in the Carpathians Curvature, Eastern Balkans, Pontic Mountains), with maximum development and frequencies in summer (as in the case of sea breezes), the ascending air on the slopes during the day accentuates the cloudiness in the early afternoon and generates showers of rain accompanied by thunder storms.

The presence of the föhn causes the air temperature to rise (especially in spring) and the precipitation to fall on the leeward side (sheltered) slopes and on the bottom of the depressions in the Curvature Subcarpathians compared to the "wind" slopes (exposed to the wind, where enough water vapor volume condenses). Being a hot and dry (non-periodic) wind, it contributes to the earlier melting of the snow, to the spring of some elements of thermophilic vegetation, to the development of fruit growing. Earlier flowering of acacia in föhn areas and later in the coastal area of Romania (through the influence of the waterbed) increases the duration of flowering throughout the South-Eastern Development Region and the possibility of increasing acacia honey production.

3.1.4 Man - climatogenic factor

Man takes actions that can improve or worsen local climatic conditions (see chapter on the environment).

Irrational deforestation is a topical issue. The reduction of forested areas changes in the first phase the initial topoclimate or microclimate, increases the thermal amplitude, increases the number of frost days (unfavorable situation for beekeeping, especially in spring), decreases air humidity, etc.

3.2 MAIN CHARACTERISTICS OF THE METEOROLOGICAL ELEMENTS

The specific way in which genetic factors are combined determines the values and regimes of each meteorological element, so that all of them, together with the characteristic meteorological phenomena generate, on a multiannual scale, a climate system with zonal differentiations, even contrasting between the North-Northwest and the South-Southeast of the Black Sea Basin Region.

The average air temperature in January (reduced at sea level) varies in latitude in the Black Sea Basin Region, as follows: in the South the isotherm of +4 ° C has a route almost parallel to the Turkish Black Sea coast near the Pontic Mountains, and in the North, the isotherm of -7 ° C reaches the northern shore area of the Azov Sea and the Donetsk region of Ukraine; the North-Western shore of the Black Sea (Danube Delta - Romania, Odessa Gulf area - Ukraine) registers values of about -1 ° C, South of Constanța (Romanian coastal area) the value increases to over + 1 ° C, reaching the coastal area southern Bulgaria at about + 4 ° C. Within the regions, the values decrease compared to those mentioned, induced by the presence of the rugged relief, more obviously in the area of the region of Romania and Bulgaria.

From January (the coldest month), the temperature values increase continuously until July (the hottest month) only to decrease incessantly until January, when the cycle resumes.

At the level of the entire Black Sea Basin, the average air temperature in July (which is low at the sea level) in the South, reaches values of + 27 ° C according to the isotherm in the Turkish Black Sea coast near the Pontic Mountains and in the North of +21 / 22 ° C, in the North of the Republic of Moldova and the Donetsk region (Ukraine).

Atmospheric precipitation (both liquid and solid) is the meteorological element that best individualizes this space. The territorial distribution of the average annual quantities is particularly eloquent from about 400 mm in the North-Northeast to over 1,500 or 2,000 mm in the South-Southeast, which greatly favours the tree vegetation.

The annual regime of the average monthly precipitation amounts brings out a rainier period in late spring and early summer (the month with the highest average amount) being determined by the intensification of frontal convection (with increasing cyclonic activity) and heat (with increasing radiative balance values) in the case of Romania, the Republic of Moldova, Ukraine.

The incessant changes that occur from one year to another in the frequency and characteristics of the air masses caused by the prevailing winds (Eest and North-Northeast) and, respectively, by mobile cyclones and anticyclones (Euro-Siberian or Eastern European anticyclone , Mediterranean Depression, South Asian Cyclone), causes significant variations in the amounts of precipitation every year, which can register negative or positive considerable deviations against the multiannual average of the Black Sea Basin Region or of the regions at the level of each state.

The region of the Black Sea Basin is characterised by: temperate-maritime climate on the Black Sea coast, in the Pontic area, with hot and humid summers, humid winters; temperate Mediterranean and transition climate (by the presence of the Marmara Sea and the Aegean Sea in the vicinity) in the regions of Turkey and Bulgaria near the Southwestern extremity of the Black Sea, with hot and dry summers; temperate continental climate, even continental accentuated in Southeastern Romania (especially in the Romanian Plain, Southern part of Dobrogea), Southern Ukraine and the Republic of Moldova; in the Crimea peninsula, there is a Mediterranean influences climate.

In the Northwestern part of the Black Sea Basin Region, the relief, by its altitudes as well as the high degree of uniformity, contributes to the continentalization of air masses by increasing the temperature, the degree of dryness and the wind speed, compared to its South-Southeast part, where the relief by position and altitude determines the increase of humidity at the same time diminishing the thermal values.

3.3 TENDENCIES IN THE CLIMATE EVOLUTION

An unanimously accepted phenomenon by the international scientific community is the global warming, caused by both natural factors (variations in solar radiation and volcanic activity) and anthropogenic (changes in the composition of the atmosphere due to human activities).

Increasing the concentration of greenhouse gas emissions in the atmosphere, especially carbon dioxide, is a major problem, being the main cause of the pronounced warming in the last 50 years of the twentieth century, 0.13ºC, about 2 times the value of the last 100 years, as presented in AR4 of IPCC / The Intergovernmental Panel on Climate Change (Guide to Adapting to the Effects of Climate Change, 2005). The United Nations Framework Convention on Climate Change (UNFCCC) established the general framework for action on combating climate change, stabilizing greenhouse gas concentrations in the atmosphere to a level that should prevent the dangerous influence of human activities on the climate system (The National Strategy on Climate Change-2013-2020).

Reducing GHG emissions contributes to improving air quality, human health, maintaining natural habitats, species of wild flora and fauna, etc. Romania and Bulgaria, EU member states, are complying with the European Union's policy objectives (adopted in the spring session of the European Council held on March 9, 2007) to reduce greenhouse gas emissions.

The climate change in the Black Sea Basin is a serious environmental concern.

The Southwestern part of the Black Sea Basin region is subject to the Mediterranean climate. A threat lies in the changes in the Mediterranean climate and the expansion of the arid climate; the Southern Europe and the entire Mediterranean basin are experiencing water shortages due to rising temperatures and declining rainfall. Simulations performed using climate models highlight the following aspects (Jose´ I. Barredo, Achille Mauri, Giovanni Caudullo, and Alessandro Dosio, 2018): in Europe, the Mediterranean climate area by the end of the XXI century will contract by 16%, an area equivalent to half the size of Italy; the Mediterranean climate zone will be extended to other areas with an area equivalent to 24 and 50% of its current extent; the expansion of the arid area is caused by the contraction of the area with a Mediterranean climate.

It should be noted that the Mediterranean basin is the richest region of biodiversity in Europe[4]; habitat loss due to climate is one of the most serious concerns for biodiversity conservation in this region.

In the western part of the Black Sea Basin, namely in Romania (according to the NMA, "Guide on adaptating to the effects of climate change) the average annual temperature increased by only 0.3 ° C compared to the increase of the global average annual temperature of 0, 6 ° C

[4] José I. Barredo, Giovanni Caudullo, Alessandro Dosio, Mediterranean habitat loss under future climate conditions: Assessing impacts on the Natura 2000 protected area network, https://www.infona.pl/resource/bwmeta1.element.elsevier-bfa8a176-eef7-3de6-9ed6-3019c8da380e

during the period 1901-2000; during 1901-2006 the increase was 0. 5^{0}C compared to 0.74 ° C globally (1906-2005)[5]. However, there were regional differences: a more pronounced warming was registered in the South and East of Romania reaching 0.8^{o}C, including in the South-East Development Region (Constanța weather station).[6]

Climate change will have an effect on biodiversity, on its ability to adapt and survive, and may be, in extreme cases, factors in the elimination of certain species from food chains with drastic consequences on the evolution of biodiversity at the local level and with an impact at the general level.

Also, the climate change impact is felt on agriculture more and more significantly. At the level of Eastern Europe, the climatic scenarios show an obvious decrease of precipitations, therefore a pluviometric deficit especially in the summer season, therefore, the most vulnerable species will be the annual crops.

Chapter 4. SOIL AND THE ENVIRONMENT STATUS IN THE BLACK SEA REGION

4.1 The impact of climate change on the environment resources in the Black Sea Basin

The climate change taking place against the background of global warming in the Black Sea Basin is of particular interest. The fundamental issue focuses mainly on the results provided by climate scenarios. All numerical climate simulations depend very much on the volume of greenhouse gas emissions. These emissions directly increase the concentrations of greenhouse gases in the atmosphere by changing the evolution of the climate system. All these scenarios simulate the environmental conditions generated by the global warming. This global warming will also have an important impact on environmental factors in the Black Sea Basin. Temperature and precipitation are the main descriptors of these climate changes. If a scenario is in fact a description of a possible future state, we can say that climate scenarios are not quantitative predictions, such as those about probable weather, but they are possible representations of future states of the general climate, which are in full agreement with assumptions about future emissions of greenhouse gases, aerosols and other air pollutants. Thus, a climate scenario is a reflection on what the future could be like in decades or even centuries, given these specific sets of assumptions about future trends in energy demand, greenhouse gas emissions, land use change, and assumptions about society's reaction to these climate changes. In analyzes based on climate scenarios, there are two main sources of uncertainty in determining the future climate: the trajectories of future emissions of greenhouse gases and aerosols, on the one hand, and the response of the global climate system to future emissions.

Climate scenarios are essential tools for assessing future developments in river basins, but they are often insufficiently understood and have high degrees of scientific uncertainty.

[5] ANM, Ghid privind adaptarea la efectele schimbărilor climatice; http://www.meteoromania.ro/anm/images/clima/SSCGhidASC.pdf
[6] ANM, Ghid privind adaptarea la efectele schimbărilor climatice; http://www.meteoromania.ro/anm/images/clima/SSCGhidASC.pdf

These climate scenarios are mainly used in assessing the impact that climate change has on beekeeping and bee populations and are strongly linked to future concentrations of the greenhouse gas. Recent data show that CO2 in the atmosphere is growing at a high rate.

Human activities have been identified as a source with a strong influence on the greenhouse effect and this by releasing a large amount of greenhouse gases into the atmosphere, such as carbon dioxide (CO2), methane (CH4), etc., as well as aerosols, which cause the temperature to rise and thus disrupt the global climate system.

The regional approach, especially in the Black Sea basin, predicts that climate change will lead to increased pressures on water resources, driven by population growth and economic land use, amid urbanization.

Current research estimates a significant future increase in the volume of precipitation, even if it is estimated that the average precipitation will decrease. The result of these changes has significantly increased the risk of floods and poses real challenges for society.

Climatic projections were made for the first time using equilibrium simulations with carbon dioxide concentrations, associated with all the other greenhouse gases. This scenario provides an image of an actual doubling of CO2 concentrations by 2040 and a 4-fold increase by around 2080 against the 1990 reference level.

Regional changes in the Black Sea Basin estimate by 2030 a warming of about 2 ° C in winter and from 2 to 3 ° C in summer. Models of these average temperature rise scenarios were made taking into account a gradual increase in greenhouse gases.

Regional patterns of temperature rise and rainfall change patterns are generally similar to those of an equilibrium simulation. The estimated impact of the climate change on the climate sensitivity ranges between 1.5 to 4.5 ° C during 1990 and 2100. In the Black Sea Basin, it is estimated that the sea levels will rise by 0.1 to 0.9 meters during this period.

General atmospheric circulation patterns remain the main source of information for regional changes in the Black Sea Basin. Climate changes in the Mediterranean and Europe support the projected regional change in the 21st century. These changes are considered to be influenced by the uncertainties of climate sensitivity and emission trajectories. Europe's average annual temperatures are likely to rise more than the global average. Depending on the season, the highest temperature rise is likely to be in northern Europe in winter and in the Mediterranean in summer. The annual number of rainy days is very likely to decrease in the Mediterranean area. The risk of drought during the summer is likely to increase in Central Europe and the Mediterranean area (Figure 4.1, 4.2). The thickness of the snow layer is likely to decrease in most of Europe.

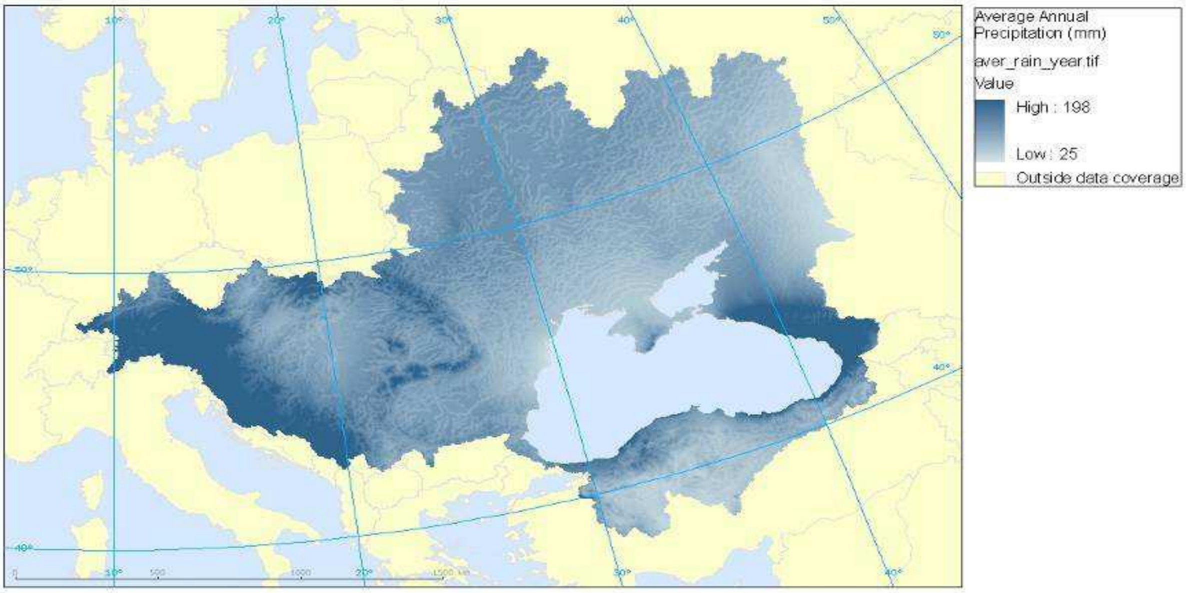

Fig. 4.1 The annual average rainfall in the Black Sea Basin
Source: FAO

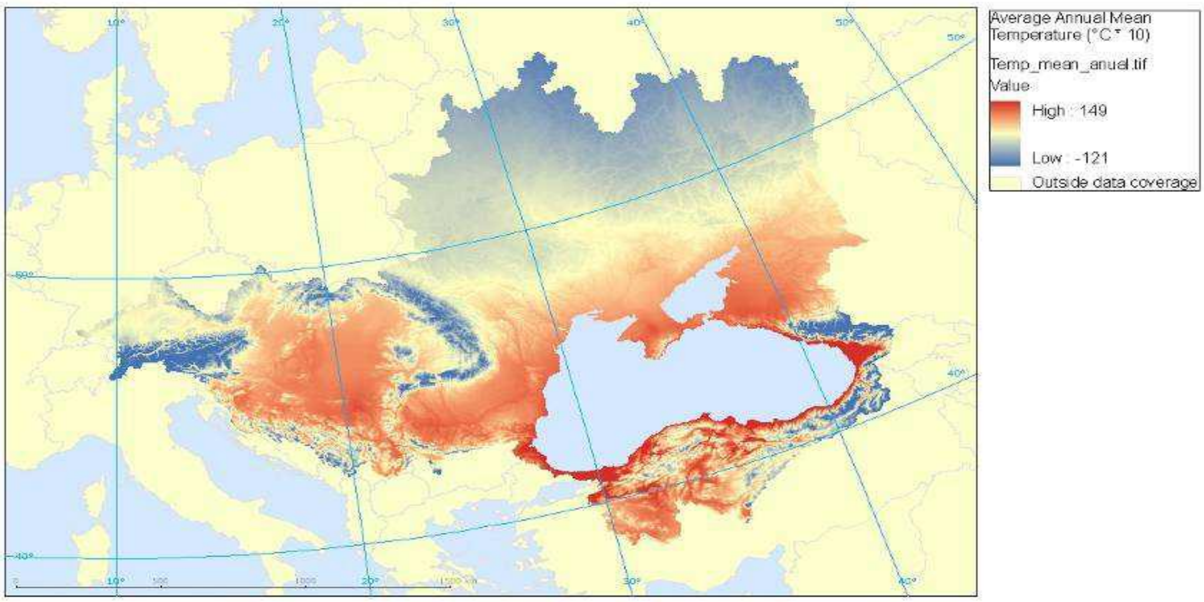

Fig. 4.2 The annual average daily temperature values in the Black Sea Basin
Source: FAO

In order to carry out environmental assessments as comprehensively as possible, multivariate techniques and criteria are commonly applied. Given the need to present an environmental situation throughout the Black Sea basin, by analyzing climate, demographic and land use change, the proposal will begin by characterizing the long-term key processes of land change with agricultural and urban practices / residential transformations. Work processes begin by exploring examples of such situations developed on the basis of widely available and globally available data sets to improve initial results.

Demography is an important force that is directly reflected in a large impact on the use of space. Demographic change is not only driven by fertility and mortality rates, but is also associated with the process of migration and urbanization. In this respect, demographics should reflect the expected increase or decrease of the total population and the urban / rural population in the Black Sea Basin region.

World population perspective The Black Sea Basin has experienced a fluctuating population growth over the last five decades. Since 1950, population growth has been especially visible in Eastern countries.

In Eastern Europe, the population would decline by 2100. The scenario corresponds to the average and shows a slight decrease in population between 2005 and 2100.

4.2 The state of environmental resources in the Black Sea Region

Following the accession of Romania and Bulgaria to the EU, the Black Sea Region has thus become an area of special interest to the European Union (EU), and this is because it is an important transit area for natural oil and gas resources from Russia and the Caspian Sea. On the other hand, due to its strategic importance, this area is subject to numerous political and military conflicts, as was the case in Ukraine a few years ago. The area is covered by two EU Member States, Romania and Bulgaria, a candidate country (Turkey) and includes the Russian Federation, as well as a number of countries such as Ukraine, Georgia, Moldova, Armenia and Azerbaijan.

The area of the Black Sea watershed is very large, with a total area of over 2 million km2, which is five times the area of the Black Sea. The main tributaries are represented by the longest and largest rivers in Europe: the Danube and the Dnieper.

The population living in the Black Sea Basin is unevenly distributed: over 15 million inhabitants in the metropolitan area of Istanbul; large cities with over 1 million inhabitants Odessa (Ukraine) and Samsun (Turkey); 800,000 inhabitants in Trabzon (Turkey) and several smaller cities with 300,000 – 450,000 inhabitants each: Constanța (Romania), Sochi (Russia), Varna (Bulgaria), Sevastopol (Crimea) and Novorossiysk (Russia).

The complex Black Sea ecosystem has been the subject of intense research. It has thus been found following this research that the intense anthropogenic changes brought to the ecosystem in the last 50 years have clearly affected its vulnerability. Adjacent terrestrial ecosystems, interconnected by tributary river basins, have been subjected to anthropogenic pressure. Marine bioresources in the Black Sea have declined sharply due to overfishing to the point of extinction of many species as a result of unsustainable development of coastal areas and heavy maritime traffic. The Black Sea River Basin in the Caucasus, Danube Delta and Eastern Carpathians is under anthropogenic pressure that threatens their survival.

The Black Sea watershed in the Caucasus, the Danube Delta and the Eastern Carpathians is subjected to an antropegenic pressure thereatening its survival.

The legal framework that offers the possibility of cooperation for the rescue and conservation of these unique ecosystems in the world is represented by the Black Sea Convention (BSC). It provides a framework for regional cooperation on pollution protection. The Convention entered into force in 1994, and following the accession of Romania and Bulgaria to the EU, the

Black Sea Basin has become a focal point of various EU policies, some targeting the environment (ecosystem protection, environmental impact assessment, access to environmental information, etc.), for example, the Integrated Coastal Zone Management (ICZM), the Marine Strategy Framework Directive (MSFD), the Water Framework Directive (WFD), Directives on Habitats and Birds; and horizontal ones, such as the Environmental Impact Assessment / Strategic Environmental Assessment (EIA / SEA), access to environmental information, control of major-accident hazards involving dangerous substances (SEVESO).

The main cross - border challenges of the Black Sea region are related to:
- biodiversity / habitat changes, including the introduction of invasive species;
- eutrophication / nutrient enrichment;
- changes in marine living resources;
- chemical pollution (including oil).

The water resources that feed the Black Sea are unevenly distributed (figure 4.3).

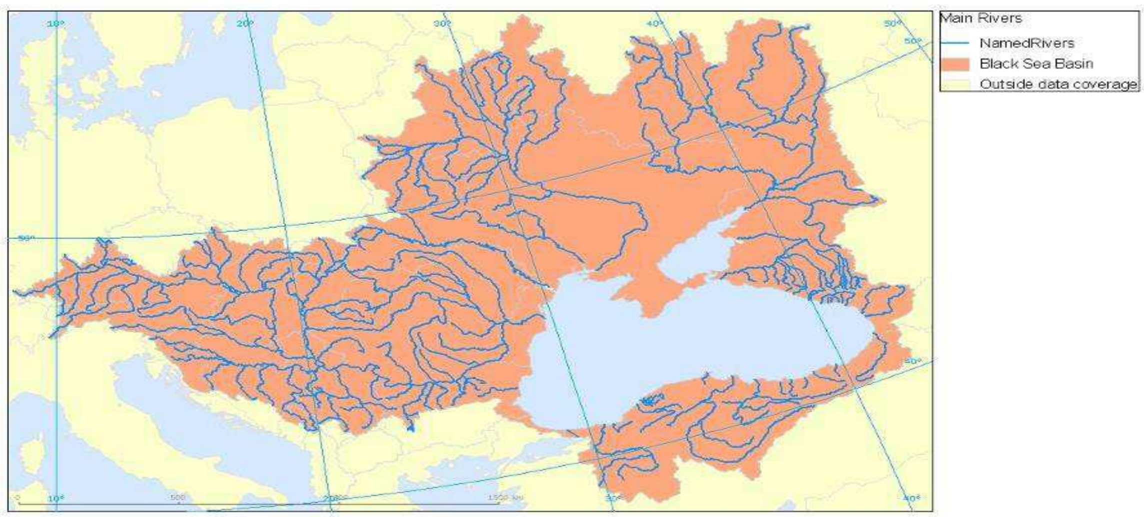

Fig. 4.3 The main tributaries of the Black Sea watershed
Source: FAO

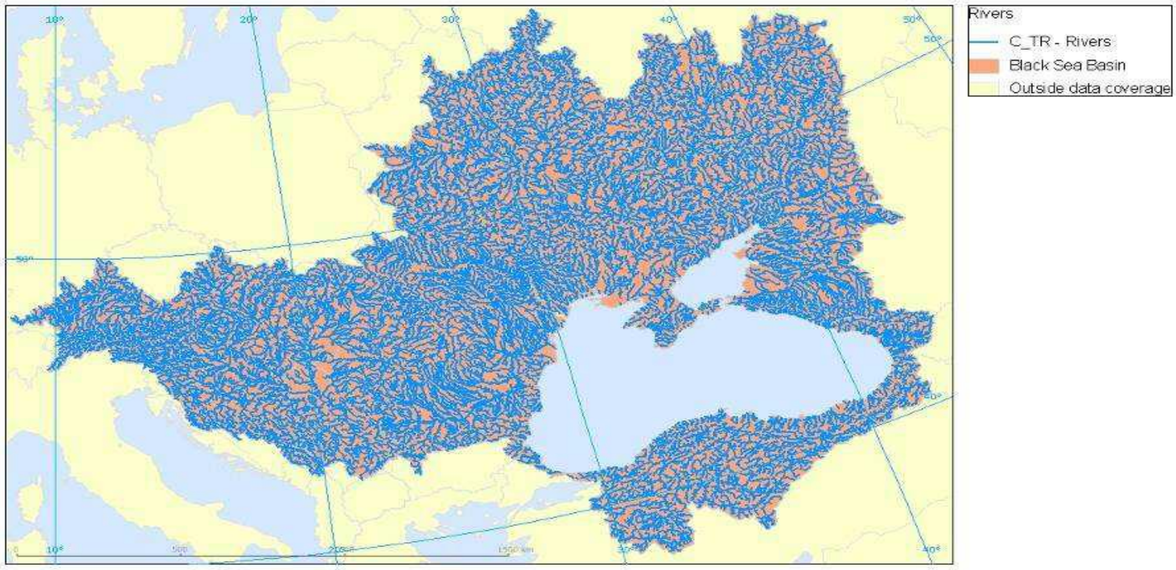

Fig. 4.4 Secondary rivers in the Black Sea watershed
Source: FAO

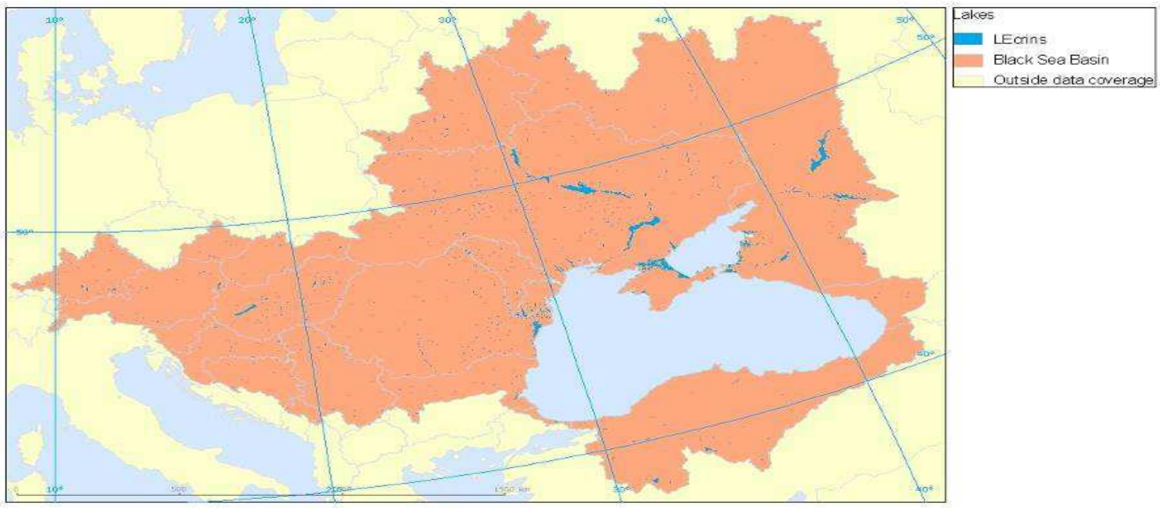

Fig. 4.5: Lakes in the Black Sea watershed
Source: FAO

Both in the Danube Basin and in the Dnieper Basin, urgent environmental protection measures are required; Romania has declared its entire territory as a vulnerable area. Thus, this declaration requires any city with more than 10,000 inhabitants to develop advanced wastewater treatment infrastructure that is able to neutralize nutrients such as nitrogen and phosphorus through biological actions. The pressure represented by the pollution of water resources counteracts the anthropogenic actions represented by the discharges of treated and untreated wastewater. However, it is considered that Romania does not risk a reduction in the availability of water resources between 2020 and 2050.

The climate change is affecting all countries in the Black Sea Basin and Romania as well. Between 1988 and 2020, average annual temperatures increased by 0.5 ° C, which is very close to the global average of 0.6 ° C. Most of the land areas in Romania were occupied by agricultural land (61.39%), followed by forested areas (28.35%).

The biodiversity of the Black Sea Basin is one of the most remarkable in Europe:

- the Danube Delta Biosphere Reservation is the most consipuous

- hosting over 300 species of birds, as well as 45 species of freshwater fish in its many lakes and swamps. If not managed properly, this biodiversity could be affected by intensive fish farming, hunting, canal and dam construction and pollution. The Danube Delta has a special importance for biodiversity, becoming a biosphere reserve. Romania has 978 areas of national interest and 531 Natura-2000 sites.

Marine and coastal environment - Black Sea: The Romanian coastal area along the Black Sea has a length of 244 km, representing 7.65% of the national border.

In 2012, the main anthropogenic pressures identified along the Romanian coast come from:

- tourism and recreation;
- constructions in touristic areas;
- expansion and modernization of existing tourist ports;
- ports and navigation;
- fishing;
- agriculture;
- petrochemical industry.

As a result of anthropogenic pressure in various forms, the Black Sea coastal area is now facing significant problems, including habitat destruction, coastal erosion, water pollution, depletion of natural resources and large-scale exploitation of natural resources.

4.3 The soil quality in the Black Sea Basin

The Black Sea region is of particular interest to the European Union (EU) for the transit of oil and gas resources from Russia and the Caspian Sea. The main cross-border challenges of the Black Sea region are the following:

• eutrophication / nutrient enrichment;
• changes in living marine resources;
• chemical pollution (including oil);
• biodiversity / habitat changes, including the introduction of alien species.

Soil quality in the Black Sea Basin is under the pressure of disruptive action of fertilizers, pesticides and industrial activities (mining, steel, energy, etc.)

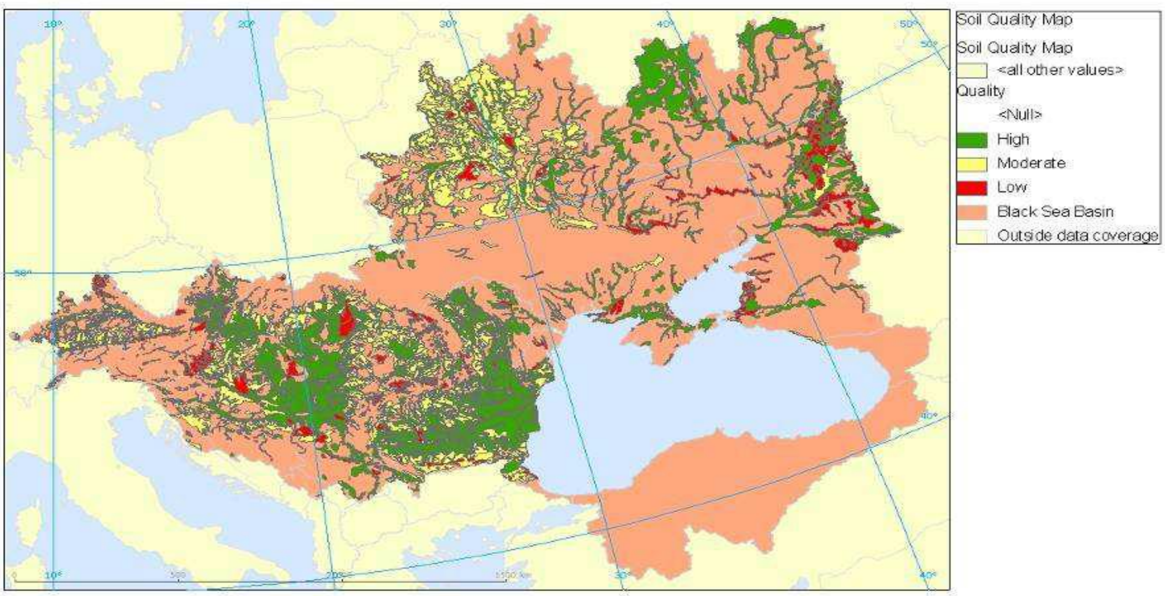

Fig. 4.6: The quality of the soil in the Black Sea Basin
Sorsa: FAO

Compared to most EU Member States, Romania is far from reaching the level of saturation in terms of phytosanitary products consumption (such as pesticides and fertilizers). Thus, the average consumption per arable hectare decreased between 1999 and 2012 from 1.18 kg active substance / ha to 0.70 kg active substance / ha. The general trend is to reduce the area of agricultural land in favor of other types of land use. Thus, since 1990, the agricultural lands in Romania have decreased by 133500 ha, which represents approximately 1% of the total agricultural lands. Forests cover approximately 27.4% of Romania's area or 6.5 million hectares. They offer a variety of products: timber, honey and medicinal and aromatic plants, game, fish, berries, edible mushrooms, wicker products, seeds, seedlings, resin.

Depending on local conditions, waves and wave flows either erode the original rocks in the coastal area, thus moving the coast to land, or build it by accumulating sediment along the shore. This results in a stable contour and a costal profile, manifesting a mobile balance among key factors. However, lower profile processes and the evolution of a stable coastline cannot be investigated in isolation, as the whole operation is highly dependent on human economic activities.

Among the mechanisms of anthropogenic transformation of physical processes in the Black Sea coastal area we can pinpoint the following: the influence of hydrotechnical constructions on coastal processe; the influence of mineral mining on coastal area and coastal ecosystems; consequences of river runoff regulations. Abnormal accumulation areas pose a much more serious danger to coastal stability. Constructions with parallel wharves have a long influence both directly and indirectly on the evolution of large sections of coast (1-2 or 5-10 km long and even more). In order to estimate the technological impact of the coast, the ratio between the length of the engineering constructions and the total length of the coast should be taken into account. This coefficient has the highest value on the Caucasian Black Sea coast.

As can be seen from the above facts, coastal and marine hydrotechnical constructions can exert a mechanical influence on sediment dynamics and coastal relief. As a result of severe disturbances in the structure of moving water bodies, the development of the entire coastal area has changed. Its typical characteristic is the proportional alternation of soft, easily destructible clayey rocks and dense sandstone, well resistant to wave erosion. The height of the rock varies up to 100 meters. The type of coast evolution can be described as abrasion-stripping. Wave erosion cuts the base of the rock and denudation erodes its surface.

Until the end of the 19th century, coastal processes took place without the human intervention. At that time, the average width of the beach reached 46 meters, enough to suppress the waves. The coast was then in a stage of stable dynamic equilibrium, when the quantities of detrital material received were approximately equal to the quantities of gravel abraded.

The active economic development of the Eastern Black Sea coast began in the early twentieth century. In those days, the gravel taken from beaches were used in the construction of buildings, in the construction of railways and roads. Such a widespread consumption of pebbles on beaches and riverbanks has led to a sharp increase in seafront abrasion and wash rate and has led to an increase in landslides. This required some development and implementation of coastal protection programs.

4.4 Actions taken and issues related to soil / land degradation and desertification

Land degradation and desertification generated by the combined effect of a number of factors: climate change, population growth, poor land management, deforestation, etc. have become issues of interest both at global level and the EU's.

Globally, soil issues are addressed in the broader concept of "land degradation" in the United Nations Convention to Combat Desertification (UNCCD), the European Environment Agency said.

Neutrality of land degradation is one of the UN's goals for sustainable development (Agenda 2030), along with other goals such as: food security and human health, urban development, those related to poverty reduction, clean water, land management, climate change and general biodiversity conservation; The Sustainable Development Goals (SDGs) were formally adopted by the Heads of State and Government of the United Nations Member States in 2015 in the global context of the Sustainable Development Agenda until 2030 (European Commission, Environment, International Activities)[7]. SDG objective 15.3 on neutrality of land degradation is committed "by 2030, to combating desertification, restoring degraded land and soil, including lands affected by desertification, drought and floods, and striving for a neutral world of soil degradation" (European Commission, Environment, international activities). It is considered that in achieving many goals, healthy soil and soil have an extremely important role.

At the conference "Soil and the SDGs: challenges and need for action" (November 25, 2019, Brussels), Rainer Baritz (EEA) stressed that one of the most important tasks is to define the impact of soil degradation, as this will contribute to raising awareness on the importance of soils and lands".

[7] https://ec.europa.eu/environment/soil/soil_international_en.htm

In addition to that, the EU, together with its partners and the international community, is addressing the challenges of land and soil degradation. The European Commission's "Thematic Strategy on Soil" of 2006 highlights the need to protect soil functions as a key element of sustainable development.

The "IMPACT ASSESSMENT OF THE THEMATIC STRATEGY ON SOIL PROTECTION" (European Commission, Brussels, 2006) mentions the idea that climate change is likely to increase the risk of threats due to several extreme weather events, such as floods and heavy rainfall, with serious consequences both for soil biodiversity and for the adequacy and possibility of producing certain crops.

An United Nations Convention to Combat Desertification (UNCCD) and several EU Member States have declared themselves affected by desertification under this Convention.

As average temperatures rise, droughts intensify and desertification increases.

Recently, at the Conference “Soil and the SDGs: challenges and need for action” (25 November 2019, Brussels) Wynn Owen (European Court of Auditors) highlighted a number of issues through maps presented on desertification, including:

- the existence of "unfavorable trends, especially in the Mediterranean area, only in the last 10 years, with the risk of increasing desertification, especially in Spain, Portugal, Romania, Bulgaria, Malta and Cyprus";

- "in Romania, the area at risk of desertification represents 30% of the total area of the country"

- "the maps are very worrying and convey a great sense of urgency."

- "the need for the EU Commission to assess the adequacy of the current legal framework on sustainable soil and desertification, which are increasingly urgent issues".

In addition to the 2 countries in the Black Sea Basin - Romania and Bulgaria, members of the EU - the other non-EU countries will be affected by this phenomenon as well. The effects are felt in the European part of Turkey (under the influence of the Mediterranean climate), the south of the Republic of Moldova and Ukraine.

As the soil, together with its adjacent atmosphere, is the environment for the development of plants, including honey ones, desertification affects beekeeping.

Under the current conditions, if drastic measures are not taken to combat desertification, the natural productive potential of soils will be called into question, especially since the level of natural fertility varies from one type of soil to another and even within the same type, from one geographical unit to another.

The manifestation of this fertility into the agricultural harvest is dependent on 2 components that are interconditioned and determined climatically, respectively an intrinsic component of the soil, which sums up all the fertility elements and determines the productive potential and a relative component, that is the favorability of this potential for different plant categories.

Rising temperatures and intensifying droughts will have a strong impact on forestry and agricultural soils, especially since the latter are anyway under the impetus of changes generated by the duration of use, crop intensity, type of crop, applied agrotechnics, etc.

4.5 Trends and evolutions on the phytopharmaceutical products market

In 1960, the crop protection industry was worth less than $ 10 billion and there were about 100 active ingredients available to farmers. Today the industry is valued at over $ 50 billion and there are approximately 600 active ingredients available to farmers worldwide (Figure 4.7).

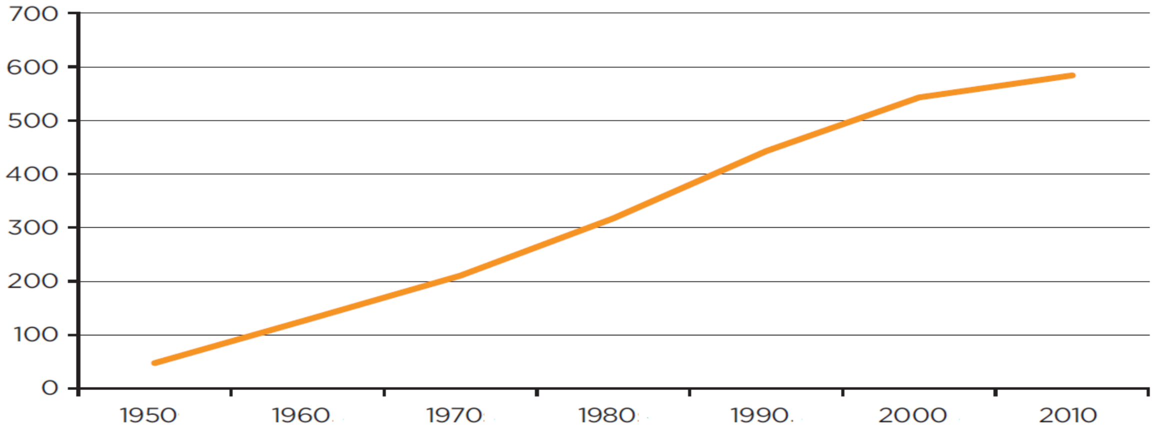

Figure 4.7: Total number of active ingredients available to farmers worldwide
Source: FAO

In 1960, there were 15 groups of chemicals on the market, today there are more than 40 different groups. New chemical groups often bring new modes of action that are important for solving resistance problems, whether they are insecticides, fungicides or herbicides. Although the approval rate of new products has decreased in recent years (Figure 3.8), investment remains high and the industry has managed to maintain a decent level of product innovation, along with other developments such as integrated culture solutions, technology for use and precision agriculture. This reflects a continuously high level of investment in research and development compared to other sectors, with large companies investing 7% -10% of their annual sales over the last 50 years (Phillips McDougall AgriService).

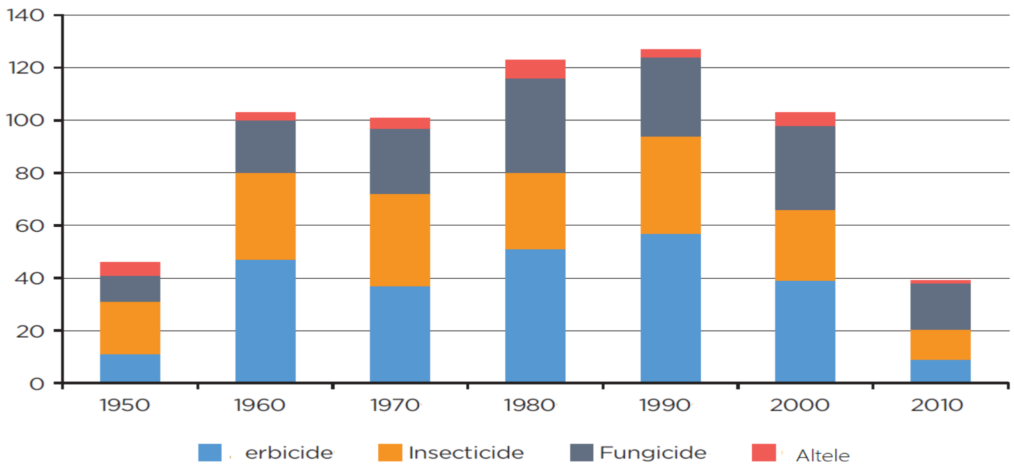

Figure 4.8: Number of new active ingredients introduced over a decade: 1950s to the present daySursa: FAO

To keep up with the new safety regulations, many products have been withdrawn from the market over the years, either as a result of the ban or because they were not supported during a proces registration. For example, the EPA has a list of over 60 active ingredients that are no longer available in the United States. The impact it has had on the use of products in the US is illustrated by comparing the top 10 products used on major American crops in 1968 with those used in 2018 (Table 3.1).

Table no. 4.1
The most used phytopharmaceuticals are

1968	2018
Atrazine	Glyphosate
Toxaphene (banned)	Metolachlor
DDT (banned)	Pyraclostrobin
2,4-D	Mesotrione
Methyl parathion (banned)	Thiamethoxam
Aldrin (banned)	Acetochlor
Trifluralin	Azoxystrobin
Propachlor	Atrazine
Dinoseb (banned)	Abamectin
Chloramben (banned)	Clothianidin

Source: FAO

DDT is banned as an agricultural and household pesticide, but control is still allowed in some countries when it is local, and affordable alternatives are not available.

In the EU, changes to the regulatory regime have imposed stricter data requirements, the introduction of hazard reduction criteria and the application of complex technical guidance procedures for risk assessment, leading to the registration of fewer new active substances.

Many of the products already on the market are unlikely to meet the new standards required. The EU re-registration process, which took place in accordance with Directive 91/414 of 1991, led to the elimination of more than half of the commercially active ingredients for crop protection (293 out of 499).

The rate of organic products introduction has increased significantly since 1960 (Figure 4.9). Between 1960 and 1990, an average of three new organic products was introduced to the world market each year. Between 1990 and 2016, 11 new biological substances on average were introduced each year. In the last 20 years, the rate of introduction of new organic products has frequently exceeded that of the conventional products and the trend seems to continue. In terms of patent activity, 2017 was the first year in which there were more patents for organic pesticides than conventional crop protection products: 173 compared to 117.

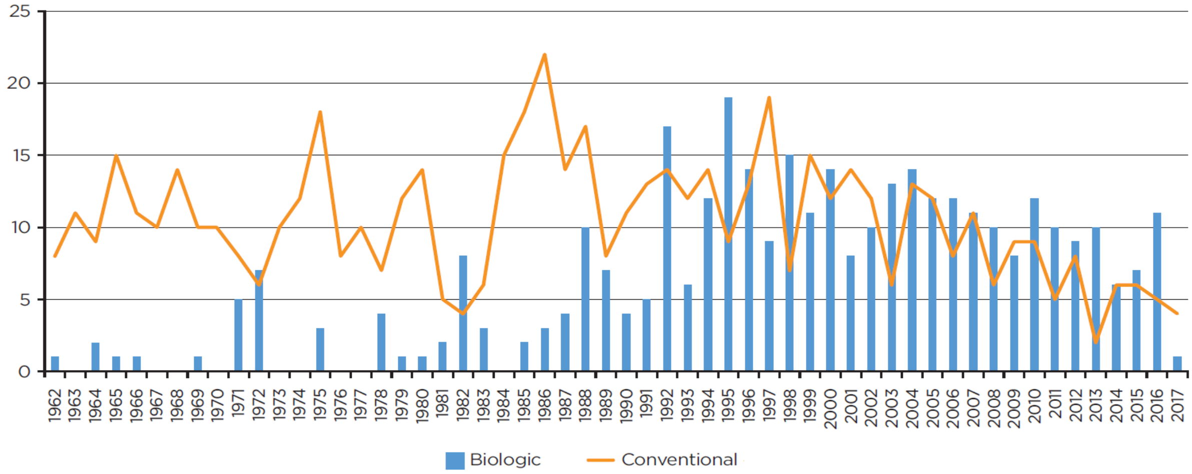

Figure 4.9: Annual introduction of new organic and conventional products
Source: FAO

Table 4.2: Growth of the biopesticides market compared to total crop protection sales

Year	Biopesticide sales, million $	Total sales of plant protection products, million $	Biopesticide market, %
1993	100	24307	0.4%
1999	250	29227	0.9%
2005	500	32814	1.5%
2009	1000	40147	2.5%
2012	500	52617	2.9%
2014	2000	59930	3.3%
2016	3000	53582	5.6%

Source: FAO

Despite its high potential and the recent rapid growth, the organic market remains relatively small, with a total value of less than 10% of the total market for crop protection products. In addition, average annual sales at maturity for an organic product are $ 10 million, compared to an average of $ 75 million for a conventional crop protection product. For the sector to continue to grow, organic products will have to prove their effectiveness for many years to come and on a large scale.

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